Palynological analysis of Billfish–1, offshore Gippsland Basin.

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Introduction

Twenty-four samples between 2800m and 3245m from across the top of Latrobe in Billfish-1 have been analysed to determine the palynological zonation and age of the sequence. The following table summarises the results:

Palynological Summary of Billfish–1

AGE	UNIT/FACIES	SPORE-POLLEN ZONES (MICROPLANKTON ZONES)	DEPTHS mKB
EARLY MIOCENE to OLIGOCENE	SEASPRAY GROUP	*P. tuberculatus* (*Operculodinium* Superzone)	2800–2880 (2800–2880)
EARLY EOCENE	LATROBE GROUP Flounder Formation equivalent	Upper *M. diversus* (*H. tasmaniense*)	2894 (2894)
PALEOCENE	LATROBE GROUP "Hapuku Formation equivalent"	Upper *L. blamei* (*A. homomorphum*) *L. blamei* undifferentiated Lower *L. blamei* (*E. crassitabulata*)	2904 (2904) 2906–2908m 2910 (2910)
MAASTRICHTIAN	LATROBE GROUP K/T boundary shale	Upper *T. longus* (*M. druggii*)	2913–2914 (2913–2914)
MAASTRICHTIAN	LATROBE GROUP Undifferentiated sand, shales and coals	Undifferentiated *T. longus* Lower *T. longus*	2916–3245 3177

An average of 14.7 grams of sample from five cuttings and an average of 7.3 grams from 19 sidewall cores were split and forwarded to Laola Pty Ltd in Perth on 10 March 1997 for processing to prepare the palynological slides for analysis. The material was returned on 18 March and initial provisional results provided on 21 March. The interpretative data with zone identification and Confidence Ratings are recorded in Table 1 and basic data on residue yields, preservation and diversity are recorded on Tables 2.

The residue yields recovered from the samples were mostly very low to low from the Latrobe Group and moderate from the Seaspray Group. Palynomorph concentrations on the slides was largely dependant on the residue yields and varied from very low to high. Preservation of palynomorphs was generally poor to

fair with occasional well preserved specimens. Average spore-pollen diversity was 14+ species per sample and average microplankton diversity was ~11 species per sample in the glauconitic facies and Seaspray Group above 2915m. In contrast the underlying undifferentiated Latrobe Group below 2915m contained very low microplankton abundance and diversity. All species which have been identified with binomial names are tabulated on Table 3. The relinquishment list for palynological slides is provided at the end of the report. No palynological residues remained after preparation of the slides.

Geological Comments

1. The cuttings and sidewall cores analysed from Billfish-1 between 2800–3245m have provided confident age dating of the basal ~90 metres of the Seaspray Group and upper ~360 metres of the Latrobe Group notwithstanding the generally low residue yields and low to moderate diversity assemblages recorded.

2. The basal Seaspray Group is sampled between 2800-2880m by cuttings which gave assemblages that could only be assigned a broad Oligocene to Early Miocene age. In general the cuttings were of poor quality because relative to sidewall cores taken for the basal Seaspray Group in other wells the palynomorph assemblages are biased towards larger and/or more robust palynomorphs. This is considered to reflect the removal of finer and softer clays during the washing and drying of the cuttings. Also the three deeper cuttings contained common, fine to coarse, mica flakes which are believed to be mud additives. Upon processing these three samples the palynological residues of were found to be dominated by coarse, fresh (not carbonised) organic matter which is atypical of Seaspray Group and is interpreted to have also been derived from a mud additive. No species were found in the assemblages recorded to confirm the presence of the Early Oligocene wedge documented in the Blackback wells and in Great White–1 (Partridge, 1994; Partridge 1997).

3. The top of the Latrobe Group is characterised by a ~27 metre thick section of glauconitic siltstones and sandstones (greensand facies) which represents a stack of condensed sections ranging in age from latest Maastrichtian to Early Eocene and which are separated by significant disconformities. Deposition was in a starved distal outer shelf marine environment. Younger Middle and Late Eocene section equivalent to the main development of the Gurnard Formation found over most of the Central Deep appears to be missing at the unconformity at the top of Latrobe.

4. The shallowest ~12 metres of the greensand facies is considered to be equivalent to the lower part of the Flounder Formation based on the recovery of a good Early Eocene assemblage belonging to the Upper *M. diversus* spore-pollen Zone and *Homotryblium tasmaniense* microplankton Zone from SWC–25 at 2894m. The other two sidewall cores from this interval at 2888m and 2899m are unfortunately both problematic.

   SWC–26 at 2888m contains unusual kerogen which is either biodegraded or partially oxidised. Only a very meagre amount of residue was recovered and this contained an unusual abundance of microforaminiferal liners but unfortunately very few specimens of the more age diagnostic spores, pollen and dinoflagellates. It is uncertain from the palynology whether the sample belongs to the Latrobe or overlying Seaspray Group. The calcareous lithology favours the latter. The unusual aspects of this sample undoubtedly relates to low depositional rates and missing section at the top of Latrobe at this location.

   SWC–24 at 2899m is considered to be out-of-place because both the calcareous claystone lithology and recovered assemblage are clearly derived from the Seaspray Group. The small size and irregular shape of the original sidewall core suggests that the bullet sampled a caved fragment within the well bore.

5. The next ~10 metres of the Latrobe Group is a richly glauconitic section which contains four good sidewall cores that are confidently assigned to the Paleocene *L. balmei* Zone. These assemblages represent a more condensed section of the informal "Hapuku Marine Sands" penetrated in Hapuku–1 and Blackback–2 (Partridge, 1993). The high glauconite content (30%-75%) at this locality is consistent with slower sediment accumulation rates in Billfish–1 based on recent studies of glauconite formation (Kelly & Webb, 1996).

6. The lower part of the Early Eocene representing the Lower and Middle *M. diversus* Zones may be missing at a disconformity or condensed between the reliable samples at 2894m and 2904m and similarly the *P. asperopolus* Zone and the three *N. asperus* Subzones are missing at disconformities or are very condensed above 2894m.

7. The bottom ~5 metres of the greensand facies is sampled by two sidewall cores which gave good assemblages belonging to the latest Maastrichtian portion of the *M. druggii* microplankton Zone based on the presence of *Manumiella seelandica*. This section represents only the lower part of the K/T boundary shale in the Gippsland Basin. On current correlations to the Haq

et al. (1987) time scale the three metre section between the *E. crassitabulata* Zone at 2910m and the top of the *M. druggii* Zone at 2913m represents a time interval of ~10 million years. The anomalous reworked occurrence of *Palaeoperidinium pyrophorum* associated with *Eisenackia crassitabulata* in the sample at 2910m suggests the time interval is highly condensed or missing through non-deposition rather than absent due to erosion.

8. All samples from the predominantly sandy undifferentiated Latrobe facies below ~2915m (with exception of SWC-2) gave low yields with few species recorded from each sample. However, when the species list is amalgamated for all samples the total assemblage favours a Lower rather than Upper *T. longus* Zone assignment. Only SWC–2 at 3177m gave a sufficiently diverse assemblage to be confident of its assignment to the Lower *T. longus* Zone. This interpretation is based on lack of any *Gambierina* abundance and absence of *Stereisporites* (*Tripunctisporis*) sp. Rare microplankton in these sands and lack of any coals suggest deposition of the section in a proximal inner shelf marine environment.

Biostratigraphy

Spore-pollen zone and age determinations are based on the scheme proposed by Stover & Partridge (1973) and modified by Helby, Morgan & Partridge (1987). The microplankton zones and ages are based on the still unpublished scheme by Partridge (1975, 1976) and the Otway Basin scheme of Harris (1985).

Author citations for most spore-pollen species can be sourced from Stover & Partridge (1973, 1982), Helby, Morgan & Partridge (1987) and Mildenhall & Pocknall (1989) or other references cited herein. Author citations for dinoflagellates can be found in the index of Lentin & Williams (1993) or other references cited herein. Species names followed by "ms" are unpublished manuscript names.

***Proteacidites tuberculatus* Spore-Pollen Zone:** **2800–2880 metres**
Oligocene to Early Miocene.

The four cuttings samples are assigned to this zone based on the presence of the key index species *Cyatheacidites annulatus*. Other index species where not recorded in the samples which were poor in spore-pollen. All the recovered assemblages are believed to be biased by the removal of the finer clays from the cuttings during washing and drying.

***Operculodinium* Microplankton Superzone:** **2800–2880 metres**
Oligocene-Miocene.

The four cuttings samples from the Seaspray Group are dominated by dinoflagellates characteristic of the *Operculodinium* Superzone which has a broad Oligocene to Miocene age range. As is typical in the superzone the assemblages contain common *Spiniferites* spp. and/or *Operculodinium centrocarpum* as well as the consistent presence of the long ranging species *Achomosphaera alcicornu, Apteodinium australiense, Dapsilidinium pseudocolligerum* and *Lingulodinium machaerophorum*. The assemblages also includes a number of key manuscript species including *Pyxidinopsis pontus* ms, *P. beta* ms, *Protoellipsodinium simplex* ms and *Tectatodinium scabroellipticus* ms which are widespread in the basin and relatively long-ranging. Of most stratigraphic significance is the occurrence in the deepest cuttings of *Protoellipsodinium mamilatus* ms. This species is found above the section identified as the "early Oligocene wedge" in both Blackback-3 and Great White-1 (Partridge, 1994; 1997). Its record here at the base of the Seaspray Group and absence of older index species such as *Fromea leos* ms suggests the "early Oligocene wedge" is not present in Billfish-1.

Upper *Malvacipollis diversus* Spore-Pollen Zone and
***Homotryblium tasmaniense* Microplankton Zone:** **2894 metres**
Early Eocene.

The dark brown-black siltstone with ~10% glauconite recovered at 2894m contains a diverse palynomorph assemblage dominated by microplankton (83%) amongst which *Homotryblium tasmaniense* was the most abundant at ~40% of the total count.

The sample is assigned to the Upper *M. diversus* Zone on the presence of *Myrtaceidites tenuis* and absence of younger index species. Although a high diversity spore-pollen assemblage was recorded the poor preservation and dominance of microplankton in the sample masked the presence of other key spore-pollen species. Compared to samples from this zone from coastal plain environments the abundance and diversity of *Proteacidites* pollen was unusually low. The most abundant groups in the assemblage were *Dilwynites* spp., *Podocarpidites* spp. and *Haloragacidites harrisii*.

The microplankton assemblage is assigned to the broad *H. tasmaniense* Zone of Harris (1985) on the dominant presence of the eponymous species. This zone was originally considered to be equivalent to only the *Kisselovia edwardsii* and *K. thompsonae* Zones by Harris (1985, fig.2) but the eponymous species is also typical and often abundant in the older *Wilsonidium ornatum* and *Rhombodinium walpawaense* Zones. Unfortunately the absence of all these index species

precludes a confident assignment of the sample to any of these "*Wetzeliella*" zones, although the presence of *Wetzeliella articulata* in the assemblage would favour assignment to the *W. ornatum* Zone based on the ranges recorded by Partridge (1975).

***Lygistepollenites balmei* Spore-Pollen Zone:** **2904–2910 metres**
Paleocene.

The four sidewall cores over this interval are assigned to the *L. balmei* Zone on the presence of the eponymous species and/or *Gambierina rudata* and absence of younger or older index species. The shallowest sample at 2904m is assigned to the Upper subzone on the presence of *Proteacidites annularis* and the deepest sample to the Lower subzone on the presence of *P. angulatus*. The two intermediate samples lack index species of either subzone and are best left as undifferentiated *L. blamei* Zone. The assemblages are dominated by *Dilwynites* spp. and *Podocarpidites* spp. suggesting the presence of a "Neves effect" (Traverse, 1988; p.413).

***Apectodinium homomorphum* Microplankton Zone:** **2904 metres**
Paleocene.

The presence of the short spined variety of *Apectodinium homomorphum* is considered diagnostic of this zone. Overall the assemblage is more diverse than usually recorded from the *A. homomorphum* Zone which in the coastal plains facies is often typified by a nearly monospecific assemblage of the eponymous species. In Billfish-1 other key species identified include *Diphyes colligerum*, *Glaphyrocysta retiintexta*, *Achomosphaera septata* and a variety of very small <30μm micro-dinoflagellates which except for *Tubulifera heterosolenia* have not been fully identified.

***Eisenackia crassitabulata* Microplankton Zone:** **2910 metres**
Paleocene.

The zone is identified by mostly fragmented specimens of the eponymous species (~5%) in a microplankton assemblage dominated by *Glaphyrocysta retiintexta* (~35%) and *Isabelidinium cingulatum* (~30%). Other significant species in the assemblage include *Deflandrea speciosus*, *Palaeocystiodinium golzowense* *Tubiosphaera filosa*, *Vozzhenikovia angulata* and *Palaeoperidinium pyrophorum*.

The two intermediate samples at 2906m and 2908m lack index species of the currently recognised microplankton zones and are not assigned to any zone. Their assemblages are consistent however with a Paleocene age.

All through the greensand facies there are anomalous occurrences of microplankton species relative to ranges established in other sections in the

Gippsland Basin. Typical examples are the anomalous old occurrence of the short spined variety of *Apectodinium homomorphum* and the anomalously young occurrence of *Palaeoperidinium pyrophorum* both with *Elsenackia crassitabulata* at 2910m. As well as the anomalously old occurrence of *Homotryblium tasmaniense* at 2904m in the highest Palaeocene sample and the occurrence of *Isabelidinium cingulatum* with abundant *M. druggii* at 2913m. All these anomalous occurrences are considered to reflect stratigraphic leakage or reworking associated with syndepositional bioturbation of the slowly accumulating greensand facies.

***Tricolpites longus* Spore-Pollen Zone:** **2913–3245 metres**
Maastrichtian.

The twelve sidewall cores and single cuttings sample over this interval gave mostly low to very low yields from which only limited spore pollen assemblages could be recorded. Amalgamating all the assemblages recorded the interval can be no younger than the *T. longus* Zone based on the youngest occurrences (LADs) of *Proteacidites reticuloconcavus* ms, *Tricolporites lilliei, Proteacidites otwayensis* ms and *Nothofagidites senectus* all recorded at 2913m and no older than this zone on the oldest occurrences (FADs) of *Forcipites* (al. *Tricolpites*) *longus*, *Tetracolporites verrucosus* and *P. reticuloconcavus* ms all recorded from the deepest sidewall core at 3177m. Another key index species for the zone is *Quadraplanus brossus* recorded in sidewall cores at 2916m and 3076m.

The samples at 2913m and 2914m are considered to belong to the Upper *T. longus* Zone based on the common occurrence of *Gambierina rudata* as well as the presence of *Stereisporites* (*Tripunctisporis*) sp. at 2913m. The lack of these features suggest all samples below 2914m probably belong to the Lower subzone but unfortunately most of the assemblages recorded are too limited to confidently assign them to the subzone. Only the deepest sidewall core at 3177m provided sufficient yield to obtain a good assemblage which can be assigned to the Lower subzone on a low *G. rudata* abundance of <2% and a high *Nothofagidites* spp. abundance of >7%.

***Manumiella druggii* Microplankton Zone:** **2913–2914 metres**
Late Maastrichtian.

The two sidewall cores from the bottom of the greensand facies are both overwhelmingly dominated by dinoflagellates cysts of the *Manumiella* species complex which comprises ~65% at 2913m and ~55% at 2914m of the total palynomorph assemblage counts. Because of fragmentation not all specimens can be identified to species level but it appears the *Manumiella conorata* is most abundant with *M. druggii* present in nearly equal abundance and *M. seelandica* relatively rare. The presence of the last species however is typical of the youngest

part of the zone where it is associated with the most consistent acme for the species complex. The presence of a single specimen of *Odontochitina* n.sp. at 2913m is considered to represent reworking (or laboratory contamination?) like the record of *Odontochitina indigena* at 2908m rather than an extension of the range of either species.

In the sandy Latrobe section below 2914m microplankton are both rare and generally non-diagnostic. The exception is *Isabelidinium greenense* recorded at 3008m which has been previously recorded at about the same stratigraphic level in Great White-1 (Partridge, 1997). Most other fragmented specimens also appear to belong to *Isabelidinium* rather than *Manumiella.*

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Table 1: Interpretative Palynological Data from Billfish-1						
Sample Type	**Depth metres**	**Spore-Pollen Zone**	***CR**	**Microplankton Zone**	***CR**	**Key Species and Comments**
Cuttings	2800	*P. tuberculatus*	D3	*Operculodinium* Superz.	D2	*Cyatheacidites annulatus* present.
Cuttings	2850	*P. tuberculatus*	D3	*Operculodinium* Superz.	D2	*Cyatheacidites annulatus* present in residue dominated by organic mud additive.
Cuttings	2870	*P. tuberculatus*	D3	*Operculodinium* Superz.	D1	*Cyatheacidites annulatus* present in residue dominated by organic mud additive.
Cuttings	2880	*P. tuberculatus*	D3	*Operculodinium* Superz.	D2	*Cyatheacidites annulatus* and *Protoellipsodinium mamillatus* ms present. Residue dominated by organic mud
SWC 26	2888	Indeterminate				Microforaminiferal liners dominate low yield sample.
SWC 25	2894	Upper *M. diversus*	B2	*H. tasmaniense*	B2	MP ~83%. *Homotryblium tasmaniense* ~42%. FADs for *Myriaceidites lenuis* and *Welzellella articulata*.
SWC 24	2899	Indeterminate		*Operculodinium* Superz.	B2	MP >98% interpreted out-of-place sample diagnostic of Seaspray Group.
SWC 23	2904	Upper *L. balmei*	B2	*A. homomorphum*	B2	MP ~45%. *Dilwynites* spp. ~45% of SP count. FAD of *Proteacidites annularis* and LAD of *Lygistepollenites*
SWC 22	2906	*L. balmei*	B2			LAD of *Gambierina rudata*.
SWC 21	2908	*L. balmei*	B2			MP ~20%. *Dilwynites* spp. ~25% of SP count.
SWC 20	2910	Lower *L. balmei*	B2	*E. crassitabulata*	B2	MP ~55%. *Dilwynites* spp. ~26% of SP count. LADs of *Elsenackia crassitabulata* and *Proteacidites angulatus*.
SWC 19	2913	Upper *T. longus*	B2	*M. druggii*	B3	MP ~73% dominated by *Manumiella* spp. at ~90% of MP count. LADs of *Proteacidites reticuloconcavus* ms and *Tricolporites lilliei*.
SWC 18	2914	Upper *T. longus*	B2	*M. druggii*	B4	MP ~55% with *Manumiella* spp. >90% of MP.
SWC 17	2916	*T. longus*	B2			LAD for *Quadraplanus brossus*.
SWC 16	2919	Indeterminate				Virtually barren.
SWC 15	2922	Indeterminate				Very low yield sample.
SWC 14	2929	*T. longus*	B2			*Battenipollis sectilis* and *Tricolporites lilliei* present.
SWC 13	2944	*T. longus*	B2			*Battenipollis sectilis* present.
SWC 11	2960	Indeterminate				Virtually barren.
SWC 8	3008	Indeterminate				Single specimen of *Isabelidinium greenense* recorded.
SWC 7	3076	*T. longus*	B3			*Quadraplanus brossus* present.
SWC 6	3128	Indeterminate				Virtually barren.
SWC 2	3177	Lower *T. longus*	B1			FADs of *Forcipites longus* and *Tetracolporites verrucosus* with *Gambierina rudata* <2%.
Cuttings	3245	*T. longus*	D3			FAD of *Proteacidites reticuloconcavus* ms.
			***CR = Confidence Rating.**			**FAD/LAD = First/Last Appearance Datums**

Confidence Ratings

The concept of Confidence Ratings applied to palaeontological zone picks was originally proposed by Dr. L.E. Stover in 1971 to aid the compilation of micropalaeontological and palynological data and to expedite the revision of the then rapidly evolving zonation concepts in the Gippsland Basin. The original scheme which mixed confidence in fossil species assemblage with confidence due to sample type gradually proved to be rather limiting as additional refinements to existing zonations were made. With the development of the STRATDAT computer database as a replacement for the increasingly unwieldy paper based Palaeontological Data Sheet files a new format for the Confidence Ratings was proposed. These are given for individual zone assignments on Table 1, and their meanings are summarised below:

Alpha codes: Linked to sample type

- **A** Core
- **B** Sidewall core
- **C** Coal cuttings
- **D** Ditch cuttings
- **E** Junk basket
- **F** Miscellaneous/unknown
- **G** Outcrop

Numeric codes: Linked to fossil assemblage

1	**Excellent confidence:**	High diversity assemblage recorded with key zone species.
2	**Good confidence:**	Moderately diverse assemblage recorded with key zone species.
3	**Fair confidence:**	Low diversity assemblage recorded with key zone species.
4	**Poor confidence:**	Moderate to high diversity assemblage recorded without key zone species.
5	**Very low confidence:**	Low diversity assemblage recorded without key zone species.

Table 2: Basic Sample and Palynomorph data from Billfish-1												
Sample Type	Depth metres	Lithology Description Modified by A.D. Partridge	SWC Rec. cms	SWC Palyn cms	Wt. gms	Vom (cc)	O/Yield	Visual Yield	Palynomorph Concentration	Preservation	No. SP Spp.	No. MP Spp.
Cuttings	2800	CALCAREOUS CLAYSTONE to CALCILUTITE medium grey.			13.1	0.4	0.030	Moderate	Moderate	Poor-fair	17	15
Cuttings	2850	CALCISILTITE medium grey. Common fine to coarse mica mud additive?			14.3	0.4	0.027	Moderate	Low	Fair-good	8	12
Cuttings	2870	CALCISILTITE medium grey. Common fine to coarse mica mud additive?			14.5	0.9	0.062	Moderate	Low	Fair	7	9
Cuttings	2880	CALCISILTITE medium grey. Common fine to coarse mica mud additive?			16.5	0.4	0.024	Moderate	Moderate	Poor-fair	17	19
SWC 26	2888	CALCISILTITE light grey, argillaceous, negligible glauconite.	2.0	1.0	8.6	0.2	0.023	Very low	Very low	Very poor	3	1
SWC 25	2894	SILTSTONE dark brown to green black, with common pelletoidal glauconite ~10%	4.5	2.0	10.3	2.1	0.203	Moderate		Poor	26	17
SWC 24	2899	CLAYSTONE calcareous, medium grey, no obvious glauconite	1.7	0.8	5.4	0.2	0.037	Very low	High	Poor	3	10
SWC 23	2904	SILTSTONE dark grey to green black with common glauconite ~30%	2.0	1.2	7.7	0.3	0.038	Low	Moderate	Poor	26	16
SWC 22	2906	GLAUCONITIC SANDSTONE dark green grey to green black fine grained with >60% glauconite.	2.5	1.2	8.3	0.2	0.024	Very low	Low	Poor	14	3
SWC 21	2908	GLAUCONITIC SANDSTONE dark green grey to green black with >75% medium grained glauconite.	2.0	1.0	9.0	0.1	0.011	Low	Moderate	Poor-fair	28	6
SWC 20	2910	GLAUCONITIC SANDSTONE green black with >75% fine grained glauconite.	1.8	0.9	8.9	0.3	0.033	Low	High	Poor-fair	26	13
SWC 19	2913	GLAUCONITIC SANDSTONE dark green with >75% fine grained glauconite.	2.5	1.0	7.9	0.3	0.037	Moderate	Moderate	Poor-fair	19	8
SWC 18	2914	GLAUCONITIC SILTSTONE green black, with floating quartz and feldspar of coarse sand to pebble size.	1.7	0.9	6.0	0.1	0.016	Low	Moderate	Poor-fair	14	3
SWC 17	2916	SANDSTONE light grey, coarse to very coarse, with patches of medium grey argillaceous matrix.	1.7	0.8	5.0	0.01	0.002	Very low	Low	Fair-good	16	2
SWC 16	2929	SANDSTONE medium grey, predominantly medium grained with silty matrix.	2.0	1.2	8.2	0.01	0.001	Very low	Virtually Barren	Fair	2	NR
SWC 15	2922	SANDSTONE medium grey, fine to medium grained with argillaceous matrix.	2.0	1.0	7.7	0.01	0.001	Very low	Very low	Poor-good	9	1

Table 2: Basic Sample and Palynomorph data from Billfish-1												
Sample Type	Depth metres	Lithology Description Modified by A.D. Partridge	SWC Rec. cms	SWC Palyn cms	Wt. gms	Vom (cc)	O/Yield	Visual Yield	Palynomorph Concentration	Preservation	No. SP Spp.	No. MP Spp.
SWC 14	2929	SANDSTONE med-light grey, fine to medium grained, minor agrillaceous matrix.	2.5	~1.0	4.6	0.1	0.021	Very low	Low	Fair-good	17	NR
SWC 13	2944	SANDSTONE med-light grey, fine to medium grained, minor agrillaceous/silty matrix.	1.8	0.7	6.1	0.05	0.008	Very low	Low	Poor-good	13	NR
SWC 12	2959.5	SANDSTONE light grey, fine to medium grained, with negligible matrix. **Not sampled for palynology.**	3.2	NA								
SWC 11	2960	SANDSTONE light grey, medium grained, well sorted with pyrite and tr. rock fragments.	2.8	1.0	9.4	0.01	0.001	Very low	Very low	Fair	4	NR
SWC 10	2961	CONGLOMERATE 60% with quartz pebbles 2-8mm and light grey, medium to coarse SANDSTONE 40%. **Not suitable for palynology.**	1.5	NA								
SWC 9	2962	SANDSTONE light grey,medium grained, well sorted with negligible matrix. **Not sampled for palynology.**	2.5	NA								
SWC 8	3008	SANDSTONE medium grey, fine to medium grained with abundant silty matrix.	<2.0	<1.0	6.7	0.1	0.014	Very low	Very low	Poor-fair	5	2
SWC 7	3076	SANDSTONE medium grey, fine to medium, common argillaceous/silty matrix.	2.0	1.0	4.7	0.05	0.010	Very low	Very low	Poor-fair	6	1
SWC 6	3128	SANDSTONE medium grey, fine to medium grained with abundant silty matrix.	1.8	0.8	5.7	0.01	0.001	Very low	Virtually Barren	Fair	1	NR
SWC 4	3143	SANDSTONE light grey, fine to medium grained with abundant silty matrix. **Not sampled for palynology.**	1.2	NA								
SWC 2	3177	Medium grey fine SANDSTONE with 0.5-2mm thick laminae of dark grey MUDSTONE.	<2.0	1.0	7.6	0.3	0.039	Moderate	Moderate	Poor-fair	42	2
Cuttings	3245	Clumped cuttings of SANDSTONE and MUDSTONE? light grey with white blotches.			15.2	0.3	0.019	Very low	Very low	Poor-fair	7	NR
										AVERAGES:	13.8	5.8

Table-3: Species List for Billfish-1, Gippsland Basin.

Sample Depths	Cts 2800	Cts 2850	Cts 2870	Cts 2880	SWC 2888	SWC 2894	SWC 2899	SWC 2904	SWC 2906	SWC 2908	SWC 2910	SWC 2913	SWC 2914	SWC 2916	SWC 2929	SWC 2922	SWC 2929	SWC 2944	SWC 2960	SWC 3008	SWC 3076	SWC 3128	SWC 3177	Cts 3245
SPORE-POLLEN SPECIES																								
Acaciapollenites myriosporites																						CV		
Aequitriradites verucosus																							X	
Aequitriradites spinulosus																							X	
Araucariacites australis	X	X	X	X		X	X	F		X	X			X				X	X				X	
Australopollis obscurus										X	X													
Baculatisporites spp.						X		X	X			X												
Battenipollis sectilis																		X					X	
Beaupreaidites orbiculatus																							X	
Camarozonosporites heskermensis												X											X	
Clavastephanocolporites meleosus				X																				
Clavifera triplex								X		X														
Corollina torosa **RW**								RW																
Crybelosporites striatus **RW**														X										
Cupanieidites orthoteichus						X																		
Cyatheacidites annulatus	F	X	X	X																				
Cyathidites australis												X		X								X	X	
Cyathidites minor																X	X						X	
Cyathidites paleospora	X			F		X		X					X											
Cyathidites splendens						X		X				X	X							X	X		X	
Dacrycarpites australiensis										X							X							
Densoisporites velatus																							X	
Dicotetradites clavatus											X													
Dictyophyllidites spp.			X																					
Dilwynites granulatus					X	A	X	A	X	A	A	X		X			X							
Dilwynites tuberculatus	X								X	X	X													
Forcipites longus																							X	
Gambierina edwardsii											X												X	
Gambierina rudata									X	X	C	C	C	X				X		X			X	
Gleicheniidites circinidites						C		C	X	C	X	X	X				X			X				
Haloragacidites harrisii	X	X	X	X		C		X		X	X											CV		
Herkosporites elliottii	X			X				X		X		X	X	X									X	
Ischyosporites gremius		X																						
Ischyosporites irregularis ms	X	X		X							X													

Table-3: Species List for Billfish-1, Gippsland Basin.

Sample Depths	Cts 2800	Cts 2850	Cts 2870	Cts 2880	SWC 2888	SWC 2894	SWC 2899	SWC 2904	SWC 2906	SWC 2908	SWC 2910	SWC 2913	SWC 2914	SWC 2916	SWC 2929	SWC 2922	SWC 2929	SWC 2944	SWC 2960	SWC 3008	SWC 3076	SWC 3128	SWC 3177	Cts 3245
Laevigatosporites major	X	X								X														
Laevigatosporites ovatus	X			X		X	X	X		X	X	X		X		X	X				X		X	X
Latrobosporites amplus																	X						X	
Latrobosporites ohiensis																							X	
Leptolepidites verrucatus **RW**																							X	
Lygistepollenites balmei								X		F	F			X		X	X			X			X	
Lygistepollenites florinii		X	X	X	X	X		X	X	X	F		X	X				X			X		X	
Malvacipollis diversus						X																		
Malvacipollis subtilis						X																		
Matonisporites ornamentalis	X		X	X																				
Microcachryidites antacticus										F	F						X	X					X	
Myrtaceidites tenuis						X																		
Nothofagidites asperus				X				X																
Nothofagidites brachyspinulosus								X	X	X														
Nothofagidites emarcidus/heturus	X			X	X	X		X	X	X	X													
Nothofagidites endurus											X												X	
Nothofagidites falcatus				X																				
Nothofagidites flemingii						X		X		X													cf	
Nothofagidites senectus												X		X		X	X	X					X	X
Peninsulapollis gillii								X	X	X	X	X	X	X		X	X	X					X	
Periporopollenites demarcatus						X																		
Periporopollenites polyoratus												X												
Perotrilites papillatus																							X	
Phyllocladidites mawsonii	X		X	X				X	X	C	C	F	X	X		X	F	F					C	
Phyllocladidites verrucosus											X													
Pilosisporites notensis **RW**																							X	
Plicatipollenites spp. **RW**									X															
Podocarpidites exiguus														X				X						
Podocarpidites spp.				X		C		F	X	A		C	X		X	X	X		X				C	X
Podosporites microsaccatus						X		X	X	X	X												F	
Polypodiaceoisporites varus ms						X																		
Polypodiidites perverrucatus	X	X																						
Proteacidites adenanthoides						X																		
Proteacidites angulatus											X													
Proteacidites annularis								X																

Table-3: Species List for Billfish-1, Gippsland Basin.

Sample Depths	Cts 2800	Cts 2850	Cts 2870	Cts 2880	SWC 2888	SWC 2894	SWC 2899	SWC 2904	SWC 2906	SWC 2908	SWC 2910	SWC 2913	SWC 2914	SWC 2916	SWC 2929	SWC 2922	SWC 2929	SWC 2944	SWC 2960	SWC 3008	SWC 3076	SWC 3128	SWC 3177	Cts 3245
Proteacidites cliner ms																	X							
Proteacidites granoratus						X																		
Proteacidites otwayensis ms												X											X	
Proteacidites palisadus												X	X										F	X
Proteacidites recticuloconcavus ms						X																		
Proteacidites reticuloscabratus								X	X	F	F	C	C	F	X	X	C	C	X				C	X
Proteacidites retiformis										X				X							X			
Proteacidites spp.																								
Proteacidites tenuiexinus								X															X	
Quadraplanus brossus																								
Reticulosporis reticulata																								
Retitriletes nodosa **RW**																								
Retitriletes spp.																								
Rudolphisporis rudolphi	X							X		X		X	X					X		X			X	
Rugulatisporites mallatus						X																		
Rugulatisporites trophus	X																							
Stereisporites (Tripunctisporis) sp.																								
Stereisporites antiquisporites	X			X		X		X		X	X	X	X	X		X	X	X					X	X
Tetracolporites verrucosus								X															X	
Tetracolpotites multistrixus ms																								
Tricolpites phillipsii																								
Tricolpites walparaensis													X											
Tricolporites lilliei																		X					X	
Tricolporites paenestriatus												X					X						X	X
Triporopollenites spp.																								
MICROPLANKTON SPECIES										X	X			X				X			X			
Achomosphaera alcicornu		X	X	X																				
Achomosphaera ramulifera							X																	
Achomosphaera septata								X																
Amosopollis cruciformis											X													
Apectodinium homomorphum (long sp.)						X															X			
Apectodinium homomorphum (short sp.)								X			X													
Apteodinium australiense		X	X	X																				

Table-3: Species List for Billfish-1, Gippsland Basin.

Sample Depths	Cts 2800	Cts 2850	Cts 2870	Cts 2880	SWC 2888	SWC 2894	SWC 2899	SWC 2904	SWC 2906	SWC 2908	SWC 2910	SWC 2913	SWC 2914	SWC 2916	SWC 2929	SWC 2922	SWC 2929	SWC 2944	SWC 2960	SWC 3008	SWC 3076	SWC 3128	SWC 3177	Cts 3245
Cleistosphaeridium sp.													X											
Cordosphaeridium inodes						X		X																
Crassosphaera concinnia	X	X																						
Cribroperidinium sp.										X														
Cyclopsiella vieta	X			X																				
Dapsilidinium pseudocolligerum	X		X	X																				
Deflandrea flounderensis						X																		
Deflandrea medcalfii											X													
Deflandrea sp. indent.						X		X																
Deflandrea speciosus											X													
Diphyes colligerum								X																
Eisenackia crassitabulata											C													
Enneadocysta spp.							X																	
Glaphyrocysta retiintexta								X			A												CV	
Glaphyrocysta sp.						C																		
Holoroginella incurvata								X																
Homotryblium tasmaniense						A	X	CV															CV	
Hystiocysta sp.											X													
Hystrichokolpoma rigaudae				X			X																	
Hystrichosphaeridium tubiferum											X													
Impagidinium maculatum				X																				
Impagidinium spp.		X		X		X	X			X		X												
Isabelidinium cingulatum											A	CV												
Isabelidinium greenense																				X				
Isabelidinium spp.														X						X				
Kallosphaeridium sp.												X												
Kenleyia spp.						X																		
Lejeunecysta sp.	X																							
Lingulodinium machaerophorum	X	X		X	X	X	X																	
Lingulodinium solarum			X	X																				
Manumiella conoratum												A	A											
Manumiella druggii												A	F											
Manumiella seelandica												F	C											
Micrystridium sp.												X												
Nematosphaeropsis labrynthius							X																	

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Sample Depths	Cts 2800	Cts 2850	Cts 2870	Cts 2880	SWC 2888	SWC 2894	SWC 2899	SWC 2904	SWC 2906	SWC 2908	SWC 2910	SWC 2913	SWC 2914	SWC 2916	SWC 2929	SWC 2922	SWC 2929	SWC 2944	SWC 2960	SWC 3008	SWC 3076	SWC 3128	SWC 3177	Cts 3245
Nematosphaeropsis rhizoma ms	X																							
Odontochitina indigena **RW**										RW														
Odontochitina n.sp.												X												
Operculodinium centrocarpum	X	X	X	C		X	A	F	X	X	X												cf	
Operculodinium tabulatum ms	X			X						X	X													
Palaeocystodinium golzowense											X													
Palaeoperidinium pyrophorum											X													
Paralecaniella indentata								X																
Pentadinium laticinctum				X																				
Protoellipsodinium mamilatus ms.				X																				
Protoellipsodinium simplex ms.	X	X	X	F																				
Pyxidinopsis beta ms	X	X	X	X																				
Pyxidinopsis delicata						X																		
Pyxidinopsis pontus ms	X	C	X	X																				
Pyxidinopsis waipawaensis						X		X																
Senegelinium dilwynense									X	cf														
Sigmopollis carbonis																								
Spinidinium sp.										X													X	
Spiniferites spp.	X	X	X	F		X	A	X		X	X													
Systematophora placacantha	X			X																			X	
Systematophora variable						X																		
Tasmanites sp.	X											X												
Tectatodinium scabroellipticus ms	X	X		X																				
Tectatodinium sp.							X																	
Tubisphaera filosa						X				X														
Tubulifera heterosolenia						X		X	X															
Vozzhennikova angulata										X														
Wetzeliella articulata						X																		
Micro-dinoflagellates indeterminate						X		X	X	X	X													
OTHER PALYNOMORPHS																								
Botryococcus sp.				X				X																
Fungal fruiting bodies						X																X		
Fungal spores & hyphae						X		X		X														
Microforaminiferal liners	C	C	F	C	C	X		X	X	X														
Scolecodonts				X				X														X		

ABBREVIATIONS

X	=	Present
F	=	Frequent
C	=	Common
A	=	Abundant
RW	=	Reworked
CV	=	Caved
cf	=	Compare with

RELINQUISHMENT LIST — PALYNOLOGY SLIDES

WELL NAME & NO: BILLFISH-1

PREPARED BY: A.D. Partridge

DATE: 21 March 1997 Sheet 1 of 1

Sample Type	Depth (m)	Catalogue Number	Description
Cuttings	2800	P197178	Kerogen slide filtered/unfiltered fractions
Cuttings	2800	P197179	Oxidised slide 2
Cuttings	2800	P197180	Oxidised slide 3 - 1/2 cover slip
Cuttings	2850	P197181	Kerogen slide filtered/unfiltered fractions
Cuttings	2850	P197182	Oxidised slide 2
Cuttings	2850	P197183	Oxidised slide 3
Cuttings	2870	P197184	Kerogen slide filtered/unfiltered fractions
Cuttings	2870	P197185	Oxidised slide 2
Cuttings	2870	P197186	Oxidised slide 3
Cuttings	2880	P197187	Kerogen slide filtered/unfiltered fractions
Cuttings	2880	P197188	Oxidised slide 2
Cuttings	2880	P197189	Oxidised slide 3 - 1/2 cover slip
SWC 26	2888	P197190	Kerogen slide filtered/unfiltered fractions
SWC 25	2894	P197191	Kerogen slide filtered/unfiltered fractions
SWC 25	2894	P197192	Oxidised slide 2
SWC 25	2894	P197193	Oxidised slide 3
SWC 24	2899	P197194	Kerogen slide filtered/unfiltered fractions
SWC 23	2904	P197195	Kerogen slide filtered/unfiltered fractions
SWC 23	2904	P197196	Oxidised slide 2
SWC 22	2906	P197197	Kerogen slide filtered/unfiltered fractions
SWC 21	2908	P197198	Kerogen slide filtered/unfiltered fractions
SWC 21	2908	P197199	Oxidised slide 2
SWC 20	2910	P197200	Kerogen slide filtered/unfiltered fractions
SWC 20	2910	P197201	Oxidised slide 2 - 18mm cover slip
SWC 19	2913	P197202	Kerogen slide filtered/unfiltered fractions
SWC 19	2913	P197203	Oxidised slide 2
SWC 19	2913	P197204	Oxidised slide 3 - 18mm cover slip
SWC 18	2914	P197205	Kerogen slide filtered/unfiltered fractions
SWC 18	2914	P197206	Oxidised slide 2 - 18mm cover slip
SWC 17	2916	P197207	Kerogen slide filtered - 15mm cover slip
SWC 16	2929	P197208	Kerogen slide filtered - 15mm cover slip
SWC 15	2922	P197209	Kerogen slide filtered - 15mm cover slip
SWC 14	2929	P197210	Kerogen slide filtered - 18mm cover slip
SWC 13	2944	P197211	Kerogen slide filtered - 18mm cover slip
SWC 11	2960	P197212	Kerogen slide filtered - 18mm cover slip
SWC 8	3008	P197213	Kerogen slide filtered/unfiltered fractions
SWC 7	3076	P197214	Kerogen slide filtered - 18mm cover slip
SWC 6	3128	P197215	Kerogen slide filtered - 15mm cover slip
SWC 2	3177	P197216	Kerogen slide filtered/unfiltered fractions
SWC 2	3177	P197217	Oxidised slide 2
SWC 2	3177	P197218	Oxidised slide 3
SWC 2	3177	P197219	Oxidised slide 4
Cuttings	3245	P197220	Kerogen slide filtered/unfiltered fractions