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**PALYNOLOGICAL ANALYSIS OF CORE AND
CUTTINGS SAMPLES FROM THE GIPPSLAND,
MURRAY AND OTWAY BASINS**

**BY:
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INTRODUCTION

These samples were submitted to Mr Macphail by the Rural Water Commission (Victoria). A copy of the results was given to the Geological Survey by Mr David Stanley (RWC).

S J TICKELL

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CORE AND CUTTINGS SAMPLES FROM THE
GIPPSLAND, MURRAY AND OTWAY BASINS

by

M.K. MACPHAIL

Palaeontological report prepared 28 July 1990

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INTRODUCTION

Nine conventional core and thirteen cuttings samples, from onshore boreholes in the Gippsland, Murray and Otway Basins in Victoria were processed and examined for spore-pollen and dinoflagellates.

With few exceptions, yields were adequate to high and preservation moderate to good, permitting these samples to be dated with a moderate to good confidence in spite of low to moderate levels of contamination.

Palynological determinations and interpreted palaeoenvironments are summarized below. Basic and interpretative data are given in Appendix 1 and check lists of all species recorded are attached. Lithological and electric log data were unavailable.

SUMMARY

BOREHOLE	DEPTH(m)	ZONE	ENVIRONMENT
BUNDALAGUAH-8	30.5	T. bellus	peatbog/lake (1:100,000 map) (SALE 8321)
"	62-63.8	T. bellus	peatbog/lake " "
"	153-154.75	T. bellus	peatbog/lake " "
BUNDALAGUAH-9	102.7-104.74	T. bellus	peatbog/swamp " "
"	157-157	T. bellus	marginal marine " "
NUNTIN 15002	9.5-82.7	C. bifurcatus	lacustrine (OMEO 8423)
"	159.6-160.6	T. bellus	marginal marine " "
TINAMBA 15083	79-80	Pliocene?	- (MAFFRA 8222)
AVENEL-8	9	Pliocene	freshwater lake (NAGAMBIE 722)
"	25-27	Pliocene	- " "
BARMAH-34	146.5-149	T. bellus	fluvio-lacustr. (MATHOURA 7826)
CARAG CARAG 109	83.4	Upper N. asperus	fluvio-lacustr. (ECHUCA 7825)
ECHUCA NTH 55	109-110	P. tuberculatus	fluvio-lacustr. " "
KANYAPELLA 38	104-106	P. tuberculatus	fluvio-lacustr. " "
MOOROOFNA W162	65.5-67.5	Pliocene?	- (SHEPPARTON 782)
TIMMERING 15	82.5-84	P. tuberculatus	fluvio-lacustr. (ECHUCA 7825)
ULUPNA 17	146-148	Upper N. asperus	fluvio-lacustr. (TUPPAL 7826)
WORMANGAL 6	38.4	T. pleistocenicus	fluvio-lacustr. (NAGAMBIE 7824)
IRREWILL 17	44	Upper T. longus	Sphagnum bog (CORANGAMITE 7521)
MELLIER 17	72.5-75.5	Upper L. balmei	fluvio-lacustr. (WILLARA 7422)
POM POM 15001	65-70	Plio-Pleistocene	peaty soil? (HAMILTON 7322)

BIOSTRATIGRAPHY

1. TAXONOMY

Fossil species names are in accordance with Stover & Partridge (1973) and subsequent revisions, notably Pocknall & Mildenhall (1984), Dettman & Jarzen (1988) and Mildenhall & Pocknall (1989). Informal species are cited in the tick sheets only when necessary to support the age-determination.

2. ZONATION

Zone and age-determinations have primarily been made using presence/absence criteria proposed by Stover & Partridge (1973), Martin (1973, 1987), Partridge (1976), Helby et al. (1987) and Macphail & Truswell (1989) but also incorporate unpublished observations made on Gippsland and Otway Basin wells and Murray Basin boreholes by A. D. Partridge, E.M. Truswell and M.K. Macphail. The informal subdivision of the I. longus Zone proposed by Macphail (1983b: see Helby et al., ibid p.58) is followed here. Zone names have not been altered to conform with nomenclatural changes to nominate species such as Tricolpites longus [now Forcipites longus].

It is noted that only an informal zonation exists for dating and correlating post-Miocene sediments in Southern Australia and some taxa cited as ranging no higher than the Middle-Late Miocene I. bellus Zone by Stover & Partridge (ibid) have since been recovered from younger sediments (A.D. Partridge & M.K. Macphail, unpubl. data; Macphail & Partridge, in prep.). Species time distributions tend to be narrower/more reliable in offshore wells and marine-influenced sections than in onshore/freshwater deposits.

Similarly time-range data based on Gippsland wells become increasingly unreliable away from this basin, particularly in the Murray Basin (see Truswell et al, 1985, Macphail & Truswell, 1989). Accordingly zone-determinations for this basin should be treated as provisional.

The relative abundance of certain long-ranging pollen types has been found to be a reliable indicator of geologic age within limited geographic areas, e.g. the Lachlan and Murrumbidgee fans by Martin (1984). Because relative abundance values are subject to strong ecological controls, quantitative criteria have been avoided in this analysis except for onshore Gippsland samples.

3. CONFIDENCE RATINGS

The reliability of each age-determination has been rated in terms of the Esso-BHP Confidence Rating Index:

- 0: Core or SWC, Excellent Confidence, assemblage with zone species of spore-pollen and/or dinoflagellates.
- 1: Core or SWC, Good Confidence, assemblage with zone species spore-pollen and/or dinoflagellates.
- 2: Core or SWC, Poor Confidence, assemblage with non-diagnostic spore-pollen and/or dinoflagellates.
- 3: Cuttings, Fair Confidence, assemblage with zone species of spore-pollen and/or dinoflagellates.
- 4: Cuttings, No Confidence, assemblage with non-diagnostic spore-pollen and/or dinoflagellates.

4. CONTAMINATION

Most samples yielded low to moderate numbers of pollen of modern exotic and native species. The former, notably Pinaceae [probably Pinus radiata] appear to have been introduced during laying out of the core rather than during processing but if mis-identified as fossil gymnosperm pollen would lead to a sample such as POM POM 15001 65-70m being dated as older than Pliocene.

Native contaminants pose a more serious problem since a number of these are morphologically very similar if not identical to species useful for dating Miocene and Pliocene samples [fossil species in parentheses]: Asteraceae [Tubulifloridites antipoda, T. similis], Chenopodiaceae-Amaranthaceae [Chenopodipollis chenopodiaceoides], Gonocarpus spp. [Haloraqacidites haloraqoides], Mvriophyllum [H. amolus, H. mvriophylloides], Monotoca and an unidentified liverwort [Cingulatisporites bifurcatus].

The Asteraceae [daisy-bush family] and Chenopodiaceae [salt-bush family] are major elements in the semi-arid zone vegetation and their pollen widely dispersed into modern dust and soil. Both types therefore should only be used as a last resort in dating samples from the Murray basin (see Macphail & Truswell, 1989). Similarly the liverwort producing Cingulatisporites bifurcatus is ubiquitous along/in creeks in South-Eastern Australia and therefore can readily contaminate samples recovered in percussion drilling.

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Oakvale-1 corehole, western Murray basin, South
Australia. BMR Journal of Australian Geology and
Geophysics 9: 267-295.

record no: 003 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: POM POM 15001 BASIN: OTWAY [onshore]

SAMPLE TYPE: cuttings ID: - DEPTH: 65-70

YIELD [spore-pollen]: v low YIELD [dinocysts]: - PRESERVN: mod.

DEPOSITIONAL ENVIRONMENT: peaty soil [based on plant macerals]

AGE: Plio-Pleistocene ZONE: - CONFID RTG: -

INDEX SPP: *Densoisporites implexus* ms [= *Selaqinella uliginosa*?]

MAXIMUM AGE: T. bellus Zone - based on *Haloraqacidites haloraqoides*

MINIMUM AGE: Pleistocene - based on *D. implexus*, *Lygistepollenites florinii*

CONTAMINANTS: Pinaceae, *Plantago lanceolata*/coronopus, Brassicaceae
REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Pinaceae [contaminant]
2. COMMON [5-30%] : *D. implexus*, *H. haloraqoides*
3. FREQUENT [1-5%] : *Lygistepollenites florinii*
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: insufficient yield

COMMENTS: Apart from *Lygistepollenites florinii* and *Nothofaqidites emarcidus-heterus* [4 and 2 grains recorded respectively], all species could be derived from any number of modern shrub communities growing in damp situations in Victoria.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 005 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: IRREWILL 17

BASIN: OTWAY [onshore]

SAMPLE TYPE: core

ID: -

DEPTH: 44

YIELD [spore-pollen]: v high YIELD [dinocysts]: - PRESERVN: v good

DEPOSITIONAL ENVIRONMENT: Sphagnum bog

AGE: Maastrichtian

ZONE: Upper T. longus

CONFID RTG: 0

INDEX SPP: *Quadruplanus brossus*, *Stereisporites (Tripunctisporis) sp.*,
Ornamentifera sentosa, *Proteacidites reticuloconcavus*,
P. otwayensis, *P. palisadus*, *Tripoporollenites sectilis*

MAXIMUM AGE: Upper T. longus Zone - based on *S. (Tripunctisporis) sp.*

MINIMUM AGE: Upper T. longus Zone - based on *Q. brossus*, *O. sentosa*,
and *T. sectilis*

CONTAMINANTS: none recorded

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : *Proteacidites spp.*, *Stereisporites spp.*
2. COMMON [5-30%] : *Camarozonosporites spp.*, *Gleicheniidites spp.*
3. FREQUENT [1-5%] : *Podocarpidites spp.*, *Laevigatosporites spp.*
4. RARE [<1%] : *Gamberina spp.*
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Shrubs and ferns established on/in a Sphagnum bog

COMMENTS: The palynoflora differs from contemporary Maastrichtian, Upper T. longus Zone palynofloras recorded in offshore wells in that *Gamberina spp.* are rare. Conversely *Camarozonosporites spp.*, including at least three undescribed types probably derived from extinct tree-ferns, are common.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 006 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: MELLIER 17 BASIN: OTWAY [onshore]

SAMPLE TYPE: cuttings ID: - DEPTH: 72.5-75.5 m

YIELD [spore-pollen]: high YIELD [dinocysts]: - PRESERV: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Paleocene ZONE: Upper L. balmei CONFID RTG: 3

INDEX SPP: *Lygistepollenites balmei*, *Gambierina* spp., *Haloragacidites harrisii*, *Cupanieidites orthoteichus*, *Verrucosisporites kopukuensis*

MAXIMUM AGE: Lower L. balmei Zone - based on *V. kopukuensis*, *H. harrisii*

MINIMUM AGE: Upper L. balmei Zone - based on *Gambierina* spp.

CONTAMINANTS: Asteraceae

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : *Podocarpidites* spp
2. COMMON [5-30%] : *Araucariacites*, *Proteacidites*, *Laevigatosporites*
3. FREQUENT [1-5%] : *Gleicheniidites*, *Tricolpites* & *Tricolporites* spp.
4. RARE [<1%] : unidentified *Triporopollenites* sp.
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Conifer (swamp?) forest

COMMENTS: The virtual absence of *Nothofagidites* and (Eocene) *Proteacidites* indicates that little or no down-hole contamination is present. The low diversity of the palynoflora is typical of Paleocene sediments deposited away from the palaeo-shoreline.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 007 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: AVENEL 8

BASIN: MURRAY

SAMPLE TYPE: cuttings

ID: -

DEPTH: 9

YIELD [spore-pollen]: negl. YIELD [dinocysts]: negl. PRESERVN: good

DEPOSITIONAL ENVIRONMENT: freshwater lake

AGE: Pliocene

ZONE: -

CONFID RTG: -

INDEX SPP: Nothofagidites falcatus, Rugulatisporites sp. cf R. cowrensis

MAXIMUM AGE: Middle Eocene - based on N. falcatus

MINIMUM AGE: Pliocene - based on N. falcatus,

CONTAMINANTS: Cingulatisporites bifurcatus?, Myriophyllum?, Asteraceae
REWORKED SPP: Stereisorites (Tripunctisporis) sp.

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] :
2. COMMON [5-30%] : Nothofagidites emarcidus-heterus
3. FREQUENT [1-5%] :
4. RARE [<1%] : freshwater algal cysts incl. Saeptodinium
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: insufficient yield

COMMENTS: Many of the palynomorphs recovered from this sample could have been derived from water used in [percussion] drilling. The date assumes Nothofagidites falcatus is in situ.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 008 date: 25/7/90 client: Rural Water Comm. of Victoria*

BOREHOLE: AVENEL 8

BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 25-27

YIELD [spore-pollen]: negl. YIELD [dinocysts]: - PRESERVN: mod.

DEPOSITIONAL ENVIRONMENT: insufficient data

AGE: Pliocene ZONE: - CONFID RTG: -

INDEX SPP: Nothofagidites falcatus

MAXIMUM AGE: Middle Eocene - based on N. falcatus

MINIMUM AGE: Pliocene - based on N. falcatus

CONTAMINANTS: Apiaceae, Asteraceae, Casuarina, Pinaceae
REWORKED SPP:

RELATIVE ABUNDANCE: n/a

1. ABUNDANT [>30%] :
2. COMMON [5-30%] :
3. FREQUENT [1-5%] :
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: insufficient yield

COMMENTS: The date assumes Nothofagidites falcatus is in situ.

The palynoflora includes a single specimen of the Plio-Pleistocene liverwort spore Cingulatisporites bifurcatus. This is likely to be a contaminant, derived from water used during the [percussion] drilling.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 009 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: BARMAN 34

BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 146.5-149 m

YIELD [spore-pollen]: high YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: late Early-Late Miocene ZONE: T. bellus CONFID RTG: 3

INDEX SPP: *Symplocoipollenites austellus*, *Polypodiaceoisporites tumulatus*, *Haloragacidites haloragoides*, *Dodonaea sphaerica*

MAXIMUM AGE: P. tuberculatus Zone - based on *Cyatheacidites annulatus*

MINIMUM AGE: Pliocene - based on *C. annulatus*, *Nothofagidites falcatus*, *Cingulatisporites bifurcatus*, *Monotoca*.

CONTAMINANTS: *Myriophyllum*, *Amperea*, *C. bifurcatus?*, *Monotoca?*

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%]: *Nothofagidites emarcidus-heterus*
2. COMMON [5-30%]: *Araucariacites*, *Podocarpidites* spp.
3. FREQUENT [1-5%]: *Pseudowinterapollis calathus*
4. RARE [<1%]: *Cyatheacidites annulatus*, *Polypod. tumulatus*
5. TRACE [<<1%]: (see attached species tick sheet)

SOURCE VEGETATION: Multistoried conifer-*Nothofagus* rainforest

COMMENTS: The existence of a floristically complex rainforest vegetation is more consistent with an Early-Middle Miocene than any younger age for this sample. As with samples from Avenel-8, it is probable that the liverwort spore *Cingulatisporites bifurcatus* and pollen of the aquatic herb *Myriophyllum* has been derived from water used in the [percussion] drilling

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 010 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: CORAG CORAG 109 BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 83.4

YIELD [spore-pollen]: v high YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Late Eocene-Early Oligocene ZONE: Upper N. asperus CONFID RTG: 3

INDEX SPP: Granodiporites nebulosus, abundant Nothofagidites spp.,

MAXIMUM AGE: Upper N. asperus Zone - based on G. nebulosus

MINIMUM AGE: P. tuberculatus Zone - based on Proteacidites stipplatus,
Ilexpollenites anguloclavatus

CONTAMINANTS: none recorded

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Nothofagidites emarcidus-heterus
2. COMMON [5-30%] : Haloragacidites harrisii
3. FREQUENT [1-5%] : Malvacipollis spp., Lygistepollenites florinii
4. RARE [<1%] : Tricolporites spp.
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Nothofagus-dominated temperate rainforest

COMMENTS: If this borehole is located away from the south-east sector of the basin, then the low relative abundance of Phyllocladidites mawsonii is consistent with a Late Eocene-Early Oligocene age. Conversely, if the borehole is located in the far south/east, then a Late Oligocene-Early Miocene age more probable.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 011 date: 25/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: ECHUCA NORTH 55 BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 109-110

YIELD [spore-pollen]: high YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Late Oligocene-Early Miocene ZONE: P. tuberculatus CONFID RTG: 4

INDEX SPP: Proteacidites stipplatus, abundant Nothofagidites spp.
including [rare] N. flemingii

MAXIMUM AGE: Middle N. asperus Zone - based on P. stipplatus, P.
rectomarginis

MINIMUM AGE: P. tuberculatus Zone - based on N. flemingii and
P. stipplatus

CONTAMINANTS: Pinaceae

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Nothofagidites emarcidus-heterus,
2. COMMON [5-30%] : Haloragacidites harrisii
3. FREQUENT [1-5%] :
4. RARE [<1%] : Tricolporites spp.
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Nothofagus-dominated temperate rainforest

COMMENTS: The majority of taxa are long-ranging species.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 012 date: 25/7/90 client: Rural water Comm. of Victoria

BOREHOLE: KANYAPPELLA 38 BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 104-106

YIELD [spore-pollen]: medium YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Oligocene-Early Miocene ZONE: P. tuberculatus CONFID RTG: 3

INDEX SPP: Proteacidites stipplatus, Nothofagidites flemingii,
Cyatheacidites annulatus

MAXIMUM AGE: P. tuberculatus Zone - based on C. annulatus and
P. stipplatus

MINIMUM AGE: P. tuberculatus Zone - based on frequent N. flemingii

CONTAMINANTS: none recorded

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Nothofagidites emarcidus-heterus
2. COMMON [5-30%] : Haloragidites harrisii
3. FREQUENT [1-5%] : Nothofagidites flemingii, Liliacidites sp.
4. RARE [<1%] : Cyatheacidites annulatus
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Nothofagus-dominated temperate rainforest

COMMENTS: The relative abundance of Nothofagidites flemingii and
Cyatheacidites annulatus is more consistent with an
Oligocene than a Miocene age.

The sample is under-oxidized and additional species may well
be present but obscured by plant macerals.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 013 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: NOOROOPNA W162 BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 65.5-67.5

YIELD [spore-pollen]: negl. YIELD [dinocysts]: - PRESERVN: mod.

DEPOSITIONAL ENVIRONMENT: insufficient data

AGE: Pliocene? ZONE: - CONFID RTG: -

INDEX SPP: Nothofagidites emarcidus-heterus, N. brachyspinulosus

MAXIMUM AGE: Tertiary - based on Nothofagidites spp.

MINIMUM AGE: Pliocene - based on Nothofagidites spp.

CONTAMINANTS: Asteraceae, Pinaceae

REWORKED SPP: none recorded

RELATIVE ABUNDANCE: n/a

1. ABUNDANT [>30%] :
2. COMMON [5-30%] :
3. FREQUENT [1-5%] :
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: insufficient yield

COMMENTS: Date assumes that Nothofagidites spp. are in situ.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 014 date: 26/6/90 client: Rural Water Comm. of Victoria

BOREHOLE: TIMMERING 15

BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 82.5-84

YIELD [spore-pollen]: high YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Oligocene-Early Miocene ZONE: *P. tuberculatus* CONFID RTG: 3

INDEX SPP: *Granodiporites nebulosus*, *Cyatheacidites annulatus*,
Proteacidites stipplatus

MAXIMUM AGE: Upper *N. asperus* Zone - based on *G. nebulosus* and absence
of Middle *N. asperus* Zone indicators.

MINIMUM AGE: *P. tuberculatus* - based on *G. nebulosus*

CONTAMINANTS: Poaceae

REWORKED SPP: *Banksieaeidites arcuatus*?

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : *Haloragacidites harrisii*
2. COMMON [5-30%] : *Nothgofagidites emarcidus-heterus*
3. FREQUENT [1-5%] : *Periporopollenites vesicus*, *Dacrycarpites*
4. RARE [<1%] : *Laevigatosporites* spp., *Proteacidites* spp.
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: *Nothofagus*-*Casuarinaceae* riparian scrub?

COMMENTS: The age-determination is supported by multiple
specimens of *Cyatheacidites annulatus* and *Rubipollis*
oblatus in the palynoflora.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 015 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: ULUPNA 17

BASIN: MURRAY

SAMPLE TYPE: cuttings ID: - DEPTH: 146-148

YIELD [spore-pollen]: high YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Late Eocene-Early Oligocene ZONE: Upper N. asperus CONFID RTG: 3

INDEX SPP: *Beaupreadites verrucosus*, *Phyllocladidites mawsonii*
[common-abundant], *Nothofagidites flemingii* [frequent]
and *Proteacidites rectomarginis* [frequent]

MAXIMUM AGE: Middle N. asperus Zone - based on *P. rectomarginis*.

MINIMUM AGE: *P. tuberculatus* Zone - based on frequent *N. flemingii*
and *B. verrucosus*

CONTAMINANTS: none recorded

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : *Nothofagidites emarcidus-heterus*
2. COMMON [5-30%] : *Proteacidites* spp. , *Phyllocladidites mawsonii*
3. FREQUENT [1-5%] : *Proteacidites rectomarginis*, *Noth. flemingii*
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: *Nothofagus-Lagarostrobos* (swamp) forest

COMMENTS: *Phyllocladidites mawsonii* [=Lagarostrobos] shows a progressive retreat towards the south-east sector of the Murray Basin during the Oligo-Miocene, presumably due to the progressive elimination of its preferred floodplain habitat. Accordingly, if Ulupma-17 is located outside of the SE sector, then the relative abundance of *P. mawsonii* pollen is evidence for a Late Eocene-Early Oligocene rather than a Late Oligocene-Miocene age for this sample.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 016 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: WORMANGAL 6 BASIN: MURRAY

SAMPLE TYPE: CUTTINGS ID: - DEPTH: 38.4

YIELD [spore-pollen]: low YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: fluvio-lacustrine

AGE: Pleistocene ZONE: "T. pleistocenicus" CONFID RTG: 3

INDEX SPP: frequent Tubulifloridites spp. (including T. pleistocenicus),
Symplocoipollenites austellus, Haloragacidites haloragoides

MAXIMUM AGE: T. bellus Zone - based on H. haloragoides and S. austellus

MINIMUM AGE: Late Pleistocene - based on S. austellus and abundant
Cyathidites spp.

CONTAMINANTS: Stellaria

REWORKED SPP: Nothofagidites flemingii

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Cyathidites spp.
2. COMMON [5-30%] : Laevigatosporites spp.
3. FREQUENT [1-5%] : Tubulifloridites spp., Pseudowinterapol. calathus
4. RARE [<1%] : Matonisporites ornamentalis
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: shrub and fern-dominated riparian plant community

COMMENTS: The virtual absence of Nothofagidites spp. is against the
sample being older than Early Pleistocene.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 017 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: BUNDALAGUAH 8 BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 30.5

YIELD [spore-pollen]: medium YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: peat bog/lacustrine

AGE: Middle-Late Miocene ZONE: (upper) T. bellus CONFID RTG: 1

INDEX SPP: Rugulatisporites cowrensis, Symplocoipollenites austellus,
Cyathidites subtilis, Cyatheacidites annulatus,
Haloragacidites haloragoides, Pseudowinterapollis calathus

MAXIMUM AGE: T. bellus Zone - based on S. austellus, H. haloragoides,
R. cowrensis.

MINIMUM AGE: Pliocene - based on C. annulatus, S. austellus

CONTAMINANTS: Tubulifloridites cf T. pleistocenicus

REWORKED SPP: Nothofagidites flemingii?, Stephanocolpites oblatius?

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Nothofagidites emarcidus-heterus
2. COMMON [5-30%] : Haloragacidites harrisii, Cyathidites spp.
3. FREQUENT [1-5%] : Nothofagidites asperus, Araucariacites australis
4. RARE [<1%] : Myrtaceidites eucalyptoides, Polypodiisporites
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Multistoried conifer-Nothofagus rainforest

COMMENTS: Desmids indicate that the depositional environment was either
a peat bog or freshwater lake.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 018 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: BUNDALAGUAH 8 BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 62.63.8

YIELD [spore-pollen]: medium YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: peat bog/freshwater lake

AGE: Middle-Late Miocene ZONE: T. bellus CONFID RTG: 0

INDEX SPP: Triporopollenites bellus, Symplocoipollenites austellus,
Rugulatisporites cowrensis, Foveotriletes lacunosus,
Cyatheacidites annulatus, Polypodiaceoisporites cf tumulatus

MAXIMUM AGE: T. bellus Zone - based on T. bellus, S. austellatus

MINIMUM AGE: T. bellus Zone - based on Verrucosisporites kopukuensis

CONTAMINANTS: Chenopodiaceae, Cingulatisporites bifurcatus?

REWORKED SPP: Rugulatisporites trophus?, Parvisaccites catastus?

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Cyathidites spp.
2. COMMON [5-30%] : Haloragacidites harrisii, Nothofagidites spp.
3. FREQUENT [1-5%] : Polypodiisporites, Pseudowinterapollis calathus
4. RARE [<1%] : Eriopites scabratus, Cyatheacidites annulatus
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Casuarinaceae scrub? bordering a bog or lake

COMMENTS: Desmids indicate that the depositional environment was either a peatbog or a freshwater lake.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 019 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: BUNDALAGUAH 8 BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 153-154.75 m

YIELD [spore-pollen]: high YIELD [dinocysts]: - PRESERVN: mod.

DEPOSITIONAL ENVIRONMENT: peatbog/freshwater lake

AGE: Middle-Late Miocene ZONE: T. bellus CONFID RTG: 0

INDEX SPP: *Triporopollenites bellus* [frequent], *Haloragacidites haloragoides*, *Polycopollenites esobalteus* [frequent].

MAXIMUM AGE: T. bellus Zone - based on frequent T. bellus

MINIMUM AGE: T. bellus Zone - based on frequent T. bellus

CONTAMINANTS: *Plantago lanceolata*/*coronopus*

REWORKED SPP: *Stepanocolpites oblatum*?

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : *Haloragacidites harrisii*
2. COMMON [5-30%] : *Nothofagidites emarcidus-heterus*, indet. 4c sp.
3. FREQUENT [1-5%] : *Triporopollenites bellus*, *Polycoporo. esobalteus*
4. RARE [<1%] : *Myrtaceidites verrucosus*
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Floristically diverse riparian scrub?

COMMENTS: Desmids indicate that the depositional environment was either a freshwater lake or a peatbog. Pollen of *Triporopollenites bellus* [= modern *Randia*], *Myrtaceidites verrucosus* [= modern *Lophomyrtus/Rhodomyrtus*] and *Polycopollenites esobalteus* [= modern *Polygalaceae*] are seldom recorded in above trace values and the unusual nature of this palynoflora is further emphasized by the abundance of an unidentified small [<12 microns diam.] tetraporate pollen. The assemblage is likely to reflect shrub species growing on the site. Otherwise, *Casuarinaceae* and *Nothofagus-brassii* group species appear to have dominated the non-local vegetation.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 020 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: BUNDALAGUAH 9 BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 102.7-104.74m

YIELD [spore-pollen]: low YIELD [dinocysts]: - PRESERVN: good

DEPOSITIONAL ENVIRONMENT: Fire hollow in peatbog/swamp?

AGE: Middle-Late Miocene ZONE: T. bellus CONFID RTG: 2

INDEX SPP: Symplacopollenites austellus, Glencopollis ornatus

MAXIMUM AGE: T. bellus Zone - based on S. austellus, Tubulifloridites antipoda

MINIMUM AGE: Pliocene - based on S. austellatus, frequent Nothofagidites spp. (including N. falcatus)

CONTAMINANTS: Myriophyllum?, Apiaceae, Poaceae

REWORKED SPP: Ilexpollenites anguloclavatus?

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Haloragacidites harrisii
2. COMMON [5-30%] : Nothofagidites emarcidus-heterus
3. FREQUENT [1-5%] : Podocarpidites spp.,
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Conifer-Nothofagus rainforest?

COMMENTS: The strew mount contains large numbers of mineral charcoal fragments. It is possible that the sample was deposited in a 'fire-hollow', similar to those recorded in the Morwell brown coal seams. It is tempting to interpret the abundance of Haloragacidites harrisii [Casuarinaceae] and presence of Glencopollis [=Polygonum] in this sample and at 2156-157m in the same borehole as representing fire-series following the destruction of temperate rainforest.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 021 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: BUNDALAGUAH 9

BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core

ID: -

DEPTH: 156-157

YIELD [spore-pollen]: high YIELD [dinocysts]: low PRESERVN: good

DEPOSITIONAL ENVIRONMENT: marginal marine

AGE: Middle-Late Miocene ZONE: (upper) T. bellus

CONFID RTG: 0

INDEX SPP: Triporopollenites bellus, Haloragacidites haloragoides,
Symplocoipollenites austellus, Rugulatisporites cowrensis,
Polypodiaceoisporites tumulatus

MAXIMUM AGE: T. bellus Zone - based on T. bellus, P. tumulatus,
S. austellus, H. haloragoides.

MINIMUM AGE: T. bellus - based on P. tumulatus

CONTAMINANTS: Cupressaceae, Pinaceae, Plantago lanceolata/coronopus

REWORKED SPP: Ilexpollenites anguloclavatus?, Stephanocolpites oblatius?

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Haloragacidites harrisii
2. COMMON [5-30%] : Nothofagidites emarcidus-heterus, Cyathidites spp.
3. FREQUENT [1-5%] : Spiniferites spp., Operculodinium spp.,
Tricolporites spp.,
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Nothofagus-dominated temperate rainforest

COMMENTS: Apart from the presence of dinoflagellates [Operculodinium spp., Spiniferites spp.], the sample closely resembles that at 102.7-104.74m in Nuntin 15002, e.g mineral charcoal is abundant and Glencopollis ornatus present in low numbers.

Although the dinoflagellates are good evidence for a marine influence at the borehole site during the Middle-Late Miocene, this is more likely to have been a temporary incursion into a coastal plain rather than representing lagoonal or estuarine conditions on the scale of Lake Wellington 23km to the east.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 022 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: NUNTIN 15002

BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 79.5-82.7 m

YIELD [spore-pollen]: low YIELD [dinocysts]: - PRESERVN: mod.

DEPOSITIONAL ENVIRONMENT: lacustrine

AGE: Pliocene ZONE: "C. bifurcatus" CONFID RTG: 2

INDEX SPP: Cingulatisporites bifurcatus, Haloragacidites haloragoides,
Rugulatisporites cowrensis [frequent]

MAXIMUM AGE: (upper) T. bellus Zone - based on H. haloragoides

MINIMUM AGE: Pliocene - based on Nothofagidites falcatus and
Lygistepollenites florinii [common]

CONTAMINANTS: Pinaceae

REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Haloragacidites harrisii
2. COMMON [5-30%] : Lygistepollenites florinii
3. FREQUENT [1-5%] : Rugulatisporites cowrensis, Polypodiisporites
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: conifer-dominated 'dry' rainforest

COMMENTS: Low but still significant numbers of Nothofagidites pollen is
against this sample being younger than Pliocene.

Algal cysts including Saeptodinium indicate that the
depositional environment was a freshwater lake - possibly of
large dimensions given the low concentration of spore-pollen.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 023 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: NUNTIN 15002 BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 159.6-160.6 m

YIELD [spore-pollen]: high YIELD [dinocysts]: low PRESERVN: good

DEPOSITIONAL ENVIRONMENT: marginal marine

AGE: Middle-Late Miocene ZONE: (upper) T. bellus CONFID RTG: 1

INDEX SPP: Triporopollenites bellus, Symplocoipollenites austellus,
Haloragacidites haloragoides, Cyatheacidites annulatus,
Rugulatisporites cowrensis

MAXIMUM AGE: T. bellus Zone - based on T. bellus, S. austellus

MINIMUM AGE: T. bellus - based on Verrucosisporites kopukuensis

CONTAMINANTS: Cingulatisporites bifurcatus?, Dodonaea sphaerica?,
Asteraceae, Cupressaceae, Pinaceae, Plantago, Poaceae

REWORKED SPP: Lygistepollenites balmei, Phyllocladidites verrucosus,
Proteacidites crassus, P. cf rugulatus

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : Nothofagidites emarcidus-heterus, Cyathidites spp.
2. COMMON [5-30%] : N. falcatus, Araucariacites,
3. FREQUENT [1-5%] : Haloragacidites harrisii, Proteacidites spp.
4. RARE [<1%] : Rugulatisporites cowrensis, C. annulatus
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: Multistoried conifer-Nothofagus rainforest

COMMENTS: The palynoflora includes two pollen species which range no higher than the Paleocene, Upper L. balmei Zone [Lygistepollenites balmei, Phyllocladidites verrucosus] and other species which are typically Eocene [Proteacidites crassus, Rugulatisporites trophus]. All are almost certainly reworked, given that the core sample yielded marine dinoflagellates [species of Nematospaeropsis, Operculodinium and Spiniferites] and therefore was deposited in a marginal marine environment (see Comments for Bundalaguah-9: 156-157m).

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369:

record no: 024 date: 26/7/90 client: Rural Water Comm. of Victoria

BOREHOLE: TINAMBA 15083 BASIN: GIPPSLAND [onshore]

SAMPLE TYPE: core ID: - DEPTH: 79-80

YIELD [spore-pollen]: v low YIELD [dinocysts]: - PRESERVN: mod.

DEPOSITIONAL ENVIRONMENT: insufficient data

AGE: Pliocene? ZONE: - CONFID RTG: -

INDEX SPP: Rugatisporites cowrensis, Nothofagidites emarcidus-heterus

MAXIMUM AGE: Tertiary

MINIMUM AGE: Pliocene - based on the persistent presence of
Nothofagidites emarcidus-heterus [6 grains]

CONTAMINANTS: Restionaceae
REWORKED SPP: none recorded

RELATIVE ABUNDANCE:

1. ABUNDANT [>30%] : (Haloragacidites harrisii)
2. COMMON [5-30%] : (N. emarcidus-heterus)
3. FREQUENT [1-5%] : (Podocarpidites spp.)
4. RARE [<1%] :
5. TRACE [<<1%] : (see attached species tick sheet)

SOURCE VEGETATION: insufficient yield

COMMENTS: The Pliocene date assumes that all palynomorphs are in situ.

Dr. M.K. Macphail Consultant Palynologist Phone/Fax 02-817-4369: