THE STRATIGRAPHIC PALYNOLOGY
of
BRIDGEWATER BAY # 1,
OTWAY BASIN.

for: PHILLIPS AUSTRALIAN OIL COMPANY.

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1. 4102-4165m - Barren.

2. 3015-4098m - Indeterminable.

Preservation is exceedingly poor here and only the most robust spores and pollen have survived. Only the ones with characteristic shapes and gross features can be identified for all the fine detail has been destroyed. All of the species which can be recognised are long ranging and of no diagnostic value. The three lowermost samples have no pollen at all, but dinoflagellates are present (see Table 2).

3. *T. pachyexinus* Zone - Coniacian into Early Campanian, 2480-2935m.
Preservation here is poor, but somewhat better than the Indeterminable Zone beneath it. The lowermost core, 2935m, contains *Latrobosporites amplus* and *Proteacidites scaboratus* which both appear within the *T. pachyexinus* Zone. Whether 2935m marks the true base of the *T. pachyexinus* Zone or whether it continues deeper, but all diagnostic species have been destroyed, cannot be determined from the palynological evidence.

4. *N. senectus* Zone - Early-Mid Campanian, 2052-2450m.
Preservation is still poor, but it improves with decreasing depth. *T. gillii*, which first appears at the base of this zone is found in 2450m. Other diagnostic species found in this Zone are *Proteacidites amolosexinus*, *Nothofagidites senectus* and *Tricolpites sabulosus*.

5. *T. lilliei* Zone - Late Campanian into Early Maastrichtian, 1495.5-2015m.
Nothofagidites endurus, which first appears at the base of the Zone is found in 2015m and other diagnostic species are found within this depth interval (see Table 1 and Figure 1).

6. *T. longus* Zone - Maastrichtian into earliest Paleocene, 1244-1457m.
The first appearance of *Proteacidites angulatus* in 1457m marks the base of the *T. longus* Zone. Stover & Partridge (1973) state that the range of *Australopollis obscurus* begins within this zone, but Dettmann & Playford (1969) show that this species first appears in the *C. triplex* Zone (Turonian) of the Otway Basin. In Bridgewater Bay, *A. obscurus* is found from the *T. pachyexinus* Zone up.

7. ?*L. balmei* Zone - Paleocene, 1210m.
Haloragacidites harrisii, which first appears within the *L. balmei* Zone is present here, but it also continues into the *M. diversus* Zone. None of the

A. SIDEWALL CORES.

SPORES and POLLEN

The spores and pollen identified are listed in Table 1 and the ranges of diagnostic species are shown on Figure 1. The species in Table 1 are grouped into three categories:-

1) Spores, mostly from ferns and their allies.
2) Gymnosperm pollen: pines e.g. hoop pine, Huon pine etc. These would have been mostly forest trees. Their relatives are found today in forests of Tasmania, New Zealand, New Caledonia and New Guinea. Only a few grow on the Australian Mainland and they are restricted to rainforests and the wetter climates.
3) Angiosperm pollen : flowering plants. These may have been trees or shrubs.

An assessment of the abundance of plant tissue debris is included in Table 1. Plant tissue debris is abundant in non marine swamps but less so in fresh water lakes. Plant tissue debris is not abundant in marine environments unless the location is close to a river outlet. However, other factors are involved with the abundance of plant tissue debris, e.g. preservation. Poor preservation may destroy or render unrecognisable much of the plant tissue debris.

The ranges of Cretaceous diagnostic species follow Dettmann & Playford (1969) who based their ranges on data from the Otway Basin. Ranges for uppermost Cretaceous and Tertiary diagnostic species follow Stover & Playford (1973) as amended by Partridge (1976). These latter ranges are based on data from the Gippsland Basin. Where ranges for the same species are available for both basins, they are not always the same. When these species are encountered in Bridgewater Bay, their ranges conform to those given for the Otway Basin. Stacey (1982) slightly modifies the original dating of the zones by Dettmann & Playford.

Partridge (1976) presents further subdivisions of the zones in Stover & Partridge (1973), but without diagnosis or definition. As the criteria for these subdivisions is unknown, they cannot be used here.

species whose ranges terminate at the top of the *T. longus* Zone are found here. The species whose ranges begin at the base of the *M. diversus* Zone are not found here either. This is a poor assemblage with insufficient evidence for a positive determination of the *L. balmei* Zone. The dinoflagellate evidence however, is more specific (see discussion below).

8. *M. diversus* Zone - Early Eocene, 984-1200m.
The 1200m level contains *Cupanieidites orthoteichus, Proteacidites grandis, P. leightonii, P. psuedomoides* and *P. reticuloscabratus* which all first appear at the base of the *M. diversus* Zone. In all, some 14 species whose ranges begin in the *M. diversus* Zone are found here.

9. *P. asperopolus* Zone - Early-Mid Eocene, 934-965m.
Heliciporites astrus, which first appears in the *P. asperopolus* Zone is found here. Species whose ranges terminate in the *M. diversus* Zone are not found here.

10. Lower *N. asperus* Zone - Late Eocene, 887m.
Proteacidites rectomarginis, which begins its range in the upper part of the Lower *N. asperus* Zone is found here. None of the species whose ranges terminate at the top of the *P. asperopolus* Zone are found here.

DINOFLAGELLATES.

The dinoflagellates identified are listed on Table 2 and the ranges of diagnostic species shown on Figure 2. Precise ranges are known for only the diagnostic species. Although ranges for the other species are not documented, the age of the type specimen is usually available, and is used as supporting evidence.

Cretaceous dinoflagellate zonation follows the scheme presented in Stacey (1982). There are no descriptions or diagnoses of the zones, but the text suggests that the first appearance of the nominate species designates the base of the zone and the first appearance of the nominate species of the next younger zone designates the top of the zone. The scheme presented in Stacey (1982) is a modification of that originally devised by Evans (1966) who clearly designates his zones by the method described above. Consequently, this method is adopted in this report.

It should be noted that the ranges of most of the nominate species extend beyond the zone, into younger zones. Harris (1983) reports one nominate species, *Xenikoon australis,* below its zone, in the older *Nelsoniella aceras* Zone. If this is not downhole contamination, then the extension of its range downwards contradicts the method used for zonation. However, it is not uncommon for the range of a species to be extended, with experience.

Tertiary dinoflagellate zonation follows Partridge (1976) and Stover et al (1979), but these zones have not been described either, so the diagnostic features are not known. It is assumed here that the method described for Cretaceous Zonation applies to the Tertiary. However, nominate species of Tertiary Zones are not often seen, so that assemblages cannot be placed in any zone, but if the ranges of the species in the assemblage are considered, they indicate a time which is in agreement with the pollen evidence.

1. ?3680-4098m, Indeterminable.

Extremely poor preservation is the reason for this zone being indeterminable. The uncertainty of the upper boundary is the result of poor preservation as well. Identification of *Odontochitina porifera,* the dominate species of the overlying zone, relies on its distinctive horns which may be broken off. Thus the lowest recorded identification occurs in 3015m, but specimens with broken off horns, recorded as *Odontochitina* sp. in Table 2, occur down to 3720m, and some of them could be *O. porifera*. In 3600m, specimens of *Odontochitina* spp. are relatively common, so the likelihood of some being *O. porifera* is increased.

There is one specimen in 3800m which resembles a badly deformed *Conosphaeridium striatoconus*. Cookson (1965) notes the frequent association of *C. striatoconus* and *Amosopollis cruciformis* in several wells of the Otway Basin. *A. cruciformis* occurs in 3720m, 3760m and possibly in 4014m (see Table 1), all poorly preserved. Thus this evidence would suggest the *C. striatoconus* Zone (see Figure 2), but it is unwise to rely on these uncertain identifications of very poorly preserved specimens. The palynological evidence is insufficient for a reliable zone designation.

2. *Odontochitina porifera* Zone - Coniacian into earliest Santonian, 2815-?3600m.

O. porifera is present and *Odontochitina* spp. are relatively common. Some of the poorly preserved specimens in the lower part of the zone are probably *O. porifera* (see discussion, page 4).

3. *Isabelidinium cretaceum* Zone - Santonian, 2650-2775m.

I. cretaceum is present throughout the Zone.

4. *Nelsoniella aceras* Zone - Late Santonian into Early Campanian, 2175-2590m.

N. aceras first appears at 2590m and is present through most of the Zone.

5. *Xenikoon australis* Zone - Middle Campanian, 2015-2130m.

X. australis first appears at 2130m and is present throughout the Zone.

6. 1700-1870m.

Dinoflagellates are present in low or trace quantities throughout this interval. Only long ranging species have been identified. The evidence is insufficient for zoning, but it does not contradict the spore-pollen evidence.

7. *Isabelidinium pellucidum* Zone - Late Campanian into Earliest Paleocene, 1244-1613m.

The long ranging *I. pellucidum* Zone of Evans (1966) is not used in Stacey (1982). However, the shorter ranging zones in the latter are not found here except for one occurrence of *Isabelidinium korojonense* (discussed further below), so it is useful to retain this older, longer ranging zone.

I. pellucidum is present through most of the interval, sometimes relatively common.

8. *Isabelidinium korojenense* Zone - Late Campanian into Early Maastrichtian, 1522m.

There is only one occurrence of this species. The zone occurs within the longer ranging *I. pellucidum* Zone.

9. 1210m - Paleocene.

Isabelidinium bakeri occurs here. This species is restricted to the early part of the Paleocene (see Figure 2).

10. 984-1000m and 1108-1200m - Early Eocene.

Dinoflagellates occur throughout these intervals but species diagnostic of zones have not been found. The ranges of all the species are in agreement with the Early Eocene *M. diversus* spore-pollen Zone.

11. *Corrudinium incompositum* Zone - Late Eocene, 887m.

The presence of this species indicates the Zone.

PALAEOECOLOGY.

Almost all of the deposition occurred under marginal marine conditions. There are four minor intervals of non marine deposition, 1910-1939m, 1663m, 1054m and 984-1000m respectively. The top of this sequence, 887m is marine.

PRESERVATION and ABUNDANCE.

A feature of the deeper levels of this well is the poor preservation which gets progressively worse with depth. As well, the abundance of spores and pollen is low, decreasing with depth.

Samples prepared for kerogen assessment showed an abundance of very fine particulate matter, some of it rod-shaped, and this is consistent with bacterial activity. Thus the scarcity of pollen probably results from initial destruction, before burial in the sediments. Alteration after burial has had an effect as well, especially in the deepest levels. Here, the spores and pollen are darker in colour, frequently deformed and the finer morphological features obliterated.

Dinoflagellates show these same trends in preservation and abundance, but to a lesser degree.

B. COMPARISON of RESULTS from SIDEWALL CORES and CUTTINGS.

Cuttings were supplied for urgent determinations. The necessary accelerated procedure for the treatment of the samples gives satisfactory results but it is not as good as the slower, normal procedure given to non-urgent samples.

The time available for microscopic examination of urgent samples was very limited. There was no time for a review or a cross check to make certain that the determinations were correct.

Determinations of *T. pachyexinus* Zone from cuttings for 2850-2935m are the same as those from sidewall cores. A result of *C. triplex* Zone from cuttings for 3165-3295m has not been confirmed by the sidewall cores which are indeterminable. The *C. triplex* Zone determination was made on the presence of two species which first appear at the base of this zone but which continue into the Campanian, at least. Thus downhole contamination would be possible and cuttings from this interval were not washed! The sidewall cores failed to yield either of these two species.

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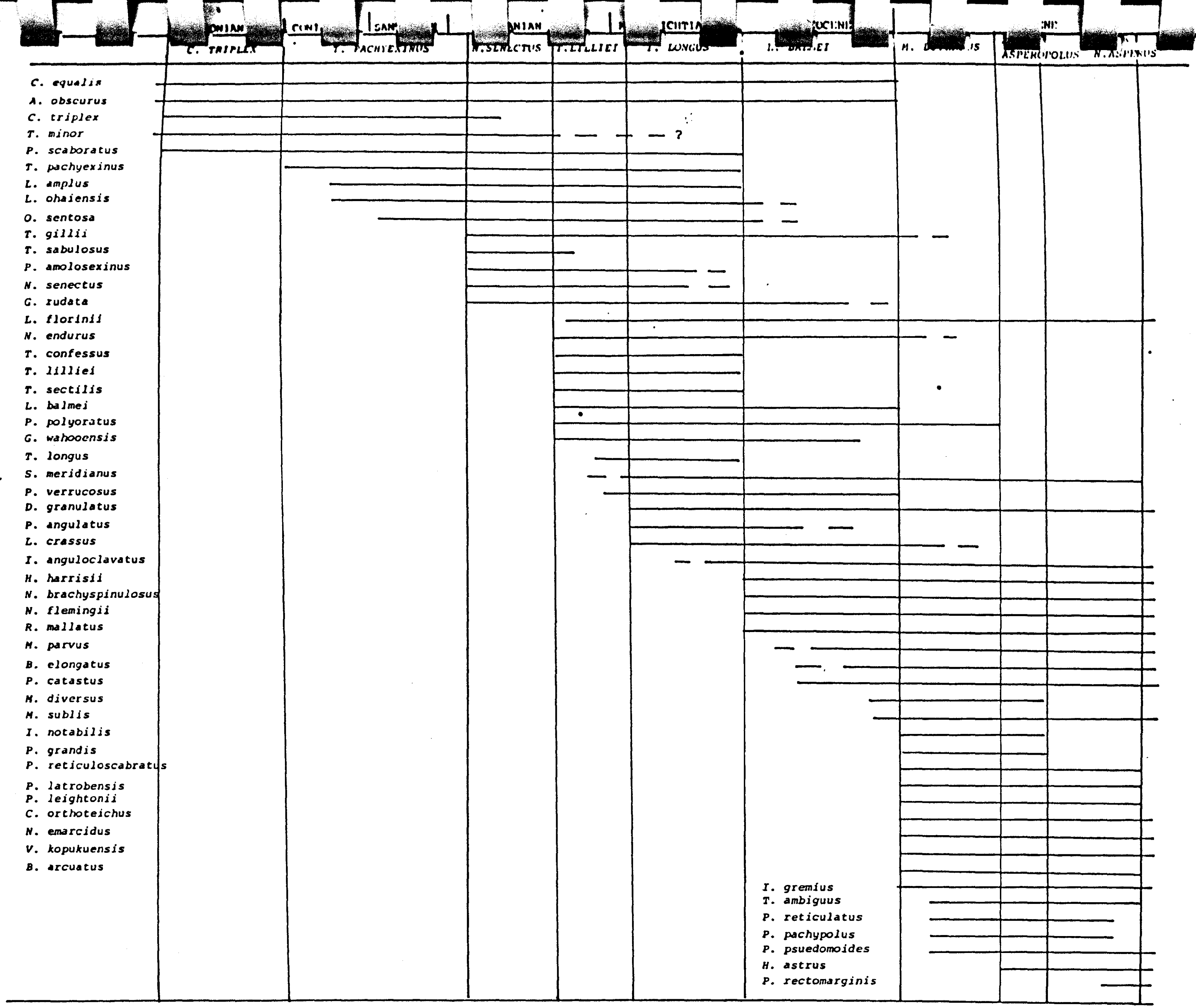


FIGURE 1: SPORE and POLLEN RANGE CHART.
From Dettmann & Playford (1969) and
Stover & Partridge (1973).

*Position of boundary modified according to reasons in Martin (1983).

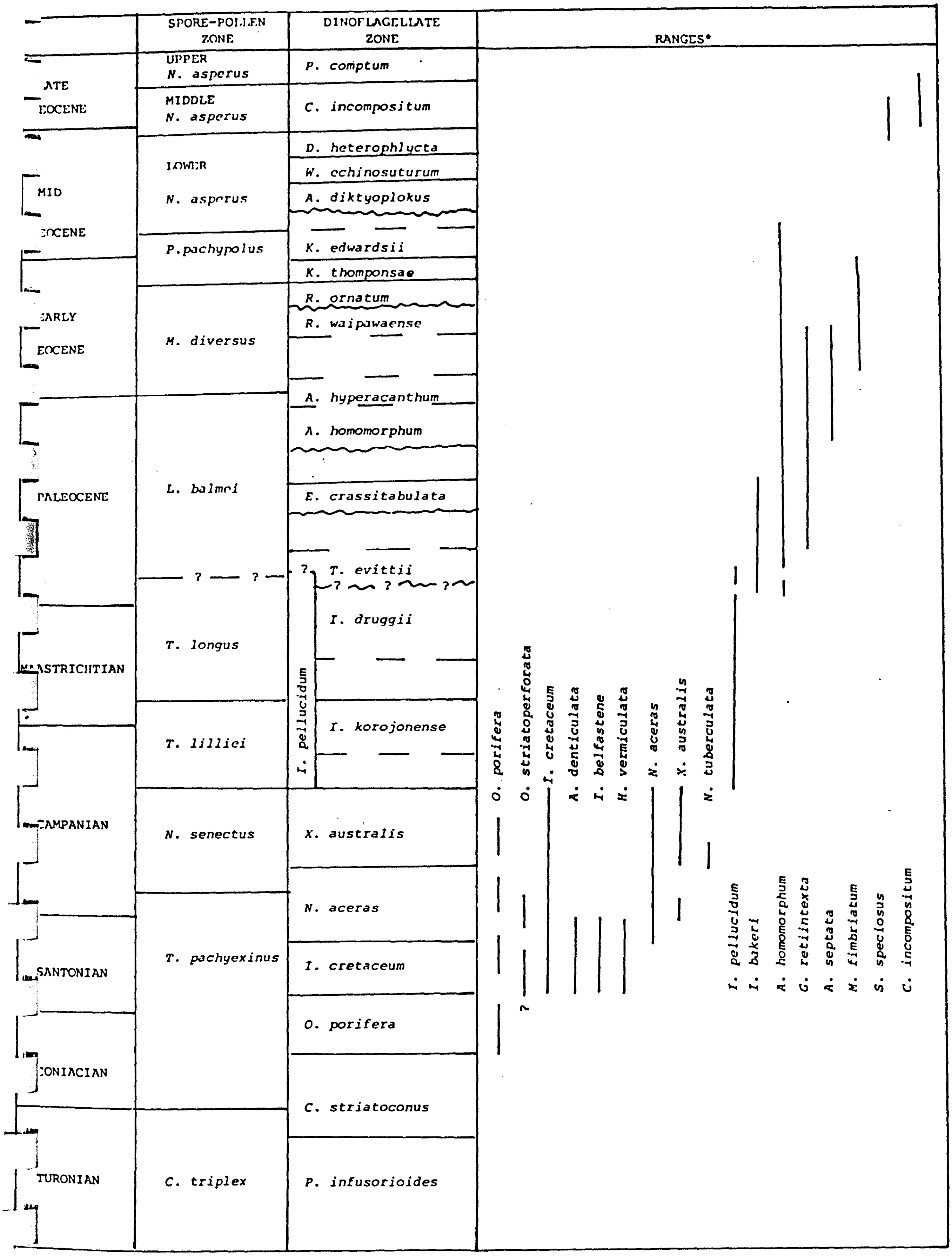
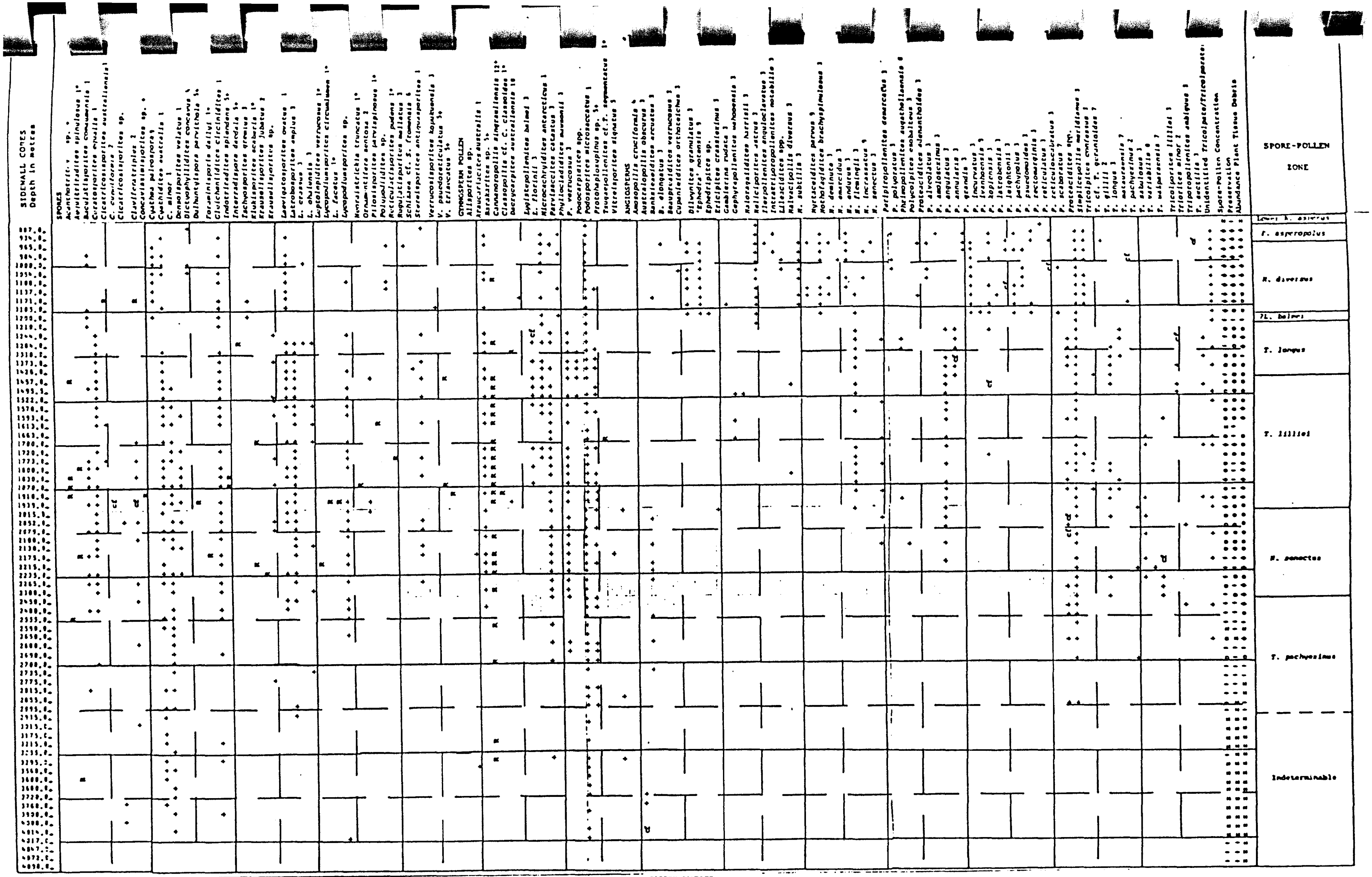


FIGURE 2: DINOFLAGELLATE RANGE CHART.

*Compiled from - Evans, 1966.
Stover, Helby & Partridge, 1979.
Stacey, 1981, 1982.
Harris, 1983.

Helene A Martin, February 1984.



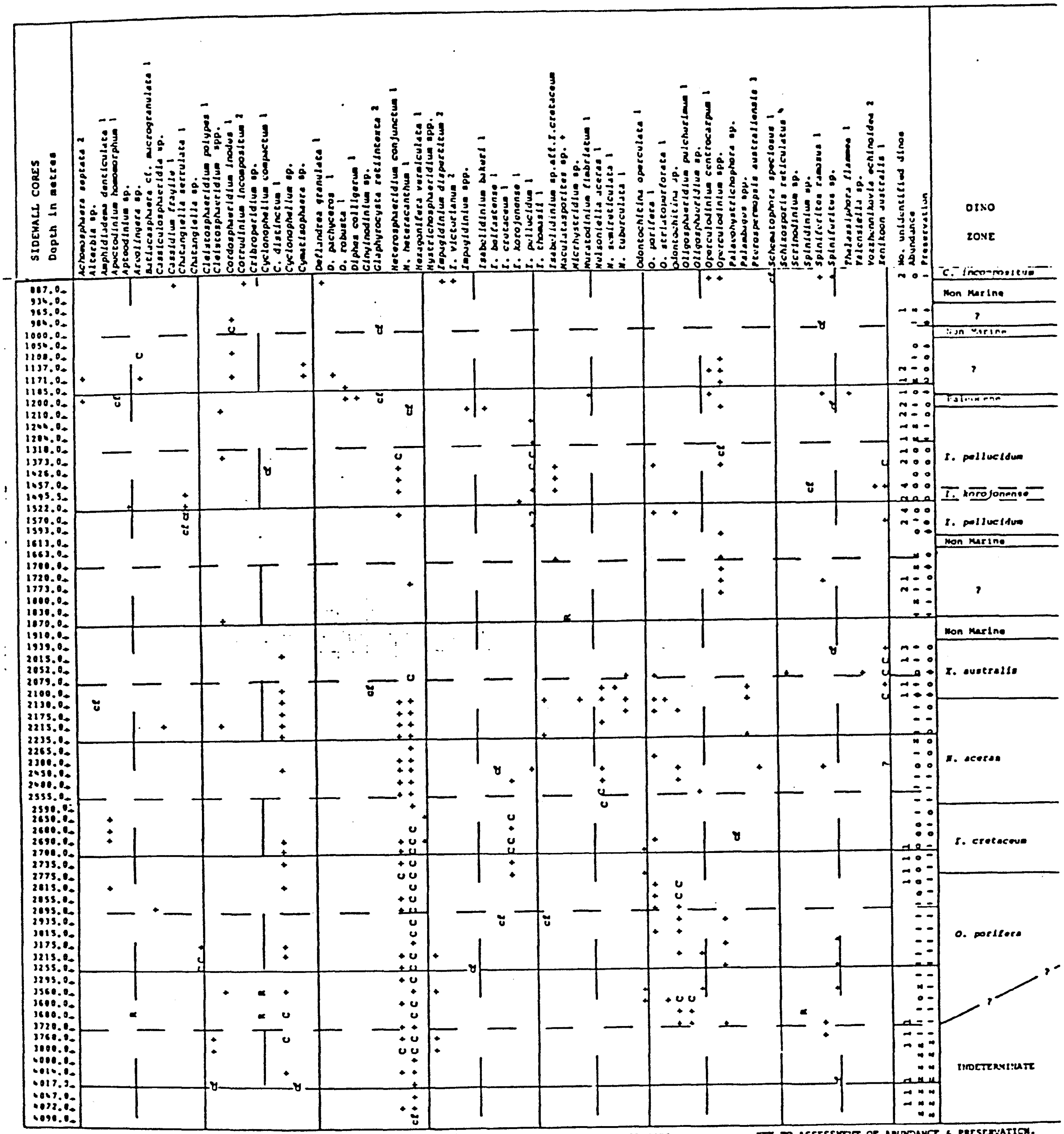
Reference to Species:
1. Dettmann, 1963
2. Dettmann & Playford, 1969
3. Stover & Partridge, 1973
4. Harris, 1965
5. Foster, 1979
6. Cookson, 1956
7. Couper, 1960
8. Norvick & Burger, 1975
9. Martin, 1973
10. Cookson & Pike, 1953

Key to assessment of abundance & preservation:
♦ : good, above average
● : average
⦁ : poor, below average
z : exceedingly poor, trace occurrence

Other Symbols:
* Early Cretaceous species
+ Permian species
R Reworked
cf Probable identification, specimens usually poorly preserved

BARREN SAMPLES:
Depth(m)
4102
4105
4109
4125
4156
4165

TABLE 1: SPORES and POLLEN IDENTIFIED IN BRIDGEWATER BAY # 1.



SIDEWALL CORES
Depth in metres

Achomosphaera septata 2
Alterbia sp.
Amphidiadema denticulata 1
Apectodinium homomorphum 1
Apteodinium sp.
Arvalingera sp.
Batiacasphaera cf. micrograndulata 1
Cassiculosphaeridia sp.
Cassidium fragile 1
Chatangiella serrulata 1
Chatangiella sp.
Cleistosphaeridium polypes 1
Cleistosphaeridium spp.
Cordosphaeridium inodes 1
Corrudinium incompositum 2
Cribroperidinium sp.
Cyclonephelium compactum 1
C. distinctum 1
Cyclonephelium sp.
Cymatiosphaera sp.
Deflandrea granulata 1
D. pachyceros 1
D. robusta 1
Diphes colligerum 1
Ginginodinium sp.
Glaphyrocysta retiintexta 2
Heterosphaeridium conjunctum 1
H. heteracanthum 1
Hexagonifera vermiculata 1
Hystrichosphaeridium spp.
Impagidinium dispertitum 2
I. victorianum 2
Impagidinium spp.
Isabelidinium bakeri 1
I. belfastense 1
I. cretaceum 1
I. korojonense 1
I. pellucidum 1
I. thomasii 1
Isabelidinium sp.aff.I.cretaceum
Maculatasporites sp. +
Micrhystridium sp.
Muratodinium fimbriatum 1
Nelsoniella aceras 1
N. semireticulata 1
N. tuberculata 1
Odontochitina operculata 1
O. porifera 1
O. striatoperforata 1
Odontochitina sp.
Oligosphaeridium pulcherrimum 1
Oligosphaeridium sp.
Operculodinium centrocarpum 1
Operculodinium spp.
Palaeohystrichophora sp.
Palambages spp.
Pterospermopsis australiensis 3
Schematophora speciosus 1
Schizosporis reticulatus 4
Scriniodinium sp.
Spinidinium sp.
Spiniferites ramosus 1
Spiniferites sp.
Thalassiphora flamma 1
Valensiella sp.
Vozzhennikovia echinoides 2
Xenikoon australis 1
No. unidentified dinos
Abundance
Preservation

DINO ZONE

887.0, 934.0, 965.0, 984.0, 1000.0, 1054.0, 1108.0, 1137.0, 1171.0, 1185.0, 1200.0, 1210.0, 1244.0, 1284.0, 1310.0, 1373.0, 1426.0, 1457.0, 1495.5, 1522.0, 1570.0, 1593.0, 1613.0, 1663.0, 1700.0, 1720.0, 1773.0, 1800.0, 1830.0, 1870.0, 1910.0, 1939.0, 2015.0, 2052.0, 2079.0, 2100.0, 2130.0, 2175.0, 2215.0, 2235.0, 2265.0, 2300.0, 2450.0, 2400.0, 2555.0, 2590.0, 2650.0, 2680.0, 2690.0, 2700.0, 2735.0, 2775.0, 2815.0, 2855.0, 2895.0, 2935.0, 3015.0, 3175.0, 3215.0, 3255.0, 3295.0, 3560.0, 3600.0, 3680.0, 3720.0, 3760.0, 3800.0, 4000.0, 4014.0, 4017.3, 4047.0, 4072.0, 4090.0

C. incompositum
Non Marine
?
Non Marine
?
Paleocene
I. pellucidum
I. korojonense
I. pellucidum
Non Marine
?
Non Marine
X. australis
N. aceras
I. cretaceum
O. porifera
? ?
INDETERMINATE

TABLE 2: DINOFLAGELLATES IDENTIFIED IN BRIDGEWATER BAY # 1.

REFERENCE TO SPECIES:
1. Lentin & Williams, 1977
2. Stover & Evitt, 1978
3. Deflandre & Cookson, 1955
4. Dettmann, 1963.

KEY TO ASSESSMENT OF ABUNDANCE & PRESERVATION.
◆ : good, above average
o : average
- : poor, below average
x : exceedingly poor, trace occurrence.

OTHER SYMBOLS:
+ : Permian species
R : Probable Reworking
cf : Probable identification, specimens usually poorly preserved
C : Relatively common

Helene A Martin, February 1984.