PALYNOLOGY OF BEACH HENKE-1,

OTWAY BASIN, AUSTRALIA

BY

ROGER MORGAN

FOR BEACH PETROLEUM

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I SUMMARY

1117m (swc) - 1263m (swc) : upper M.diversus Zone : Early Eocene : nearshore to marginal marine : immature.

1268m (swc) - 1285m (swc) : middle M.diversus Zone : Early Eocene : nearshore marine : immature.

1310m (swc) - 1321.5m (swc) : upper L.balmei Zone (dinoflagellate Zone unknown) : late Paleocene : nearshore to offshore marine : immature.

1327.5m (swc) : lower L.balmei Zone (T.evittii Dinoflagellate Zone) : offshore marine : immature.

1330m (swc) - 1430m (swc) : T.longus Zone : Maastrichtian : brackish at 1430m, nearshore marine (M.druggii Dinoflagellate Zone) 1358m to 1330m : marginally mature.

II INTRODUCTION

Twelve sidewall cores were examined from Beach Henke-1 for biostratigraphy and spore colour. Yields were generally good. The samples are assigned to five palynological zones on the basis of the supporting data presented here as Appendix I. The Cretaceous zonation used is basically that of Helby, Morgan and Partridge (1987), which draws on all previous work. The Tertiary zonation is that of Stover and Partridge (1973) and Stover and Evans (1973) as modified by Partridge (1976).

Maturity data was generated on the Thermal Alteration Index (TAI) Scale of Staplin and plotted on Figure 2 as a Maturity Profile. The oil and gas windows on Figure 2 follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (2.7) to dark brown (3.6) and would correspond to Vitrinite Reflectances of 0.6% to 1.3%. Geochemists, however, have not reached universal agreement on these values and argue variations based 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 would probably not move the oil window by more than 200 metres. Instrumental geochemistry offers quantitative and repeatable raw data.

	AGE		SPORE - POLLEN ZONES	DINOFLAGELLATE ZONES
Early Tertiary	Early Oligocene		P. tuberculatus	
	Late Eocene		upper N. asperus	P. comatum
			middle N. asperus	V. extensa
	Middle Eocene		lower N. asperus	D. heterophlycta
			P. asperopolus	W. echinosuturata
	Early Eocene		upper M. diversus	W. edwardsii W. thompsonae W. ornata W. waipawaensis
			middle M. diversus	
			lower M. diversus	W. hyperacantha
	Paleocene		upper L. balmei	A. homomorpha
			lower L. balmei	E. crassitabulata T. evittii
Late Cretaceous	Maastrichtian		T. longus	M. druggii
	Campanian		T. lilliei	I.korojonense
			N. senectus	X. australis
	Santonian		T. pachyexinus	N. aceras I. cretaceum O. porifera
	Coniacian		C. tripiex	
	Turonian			C. striatoconus
	Cenomanian		A. distocarinatus	P. infusorioides
Early Cretaceous	Albian	Late	P. pannosus	
		Middle	upper C. paradoxa	
			lower C. paradoxa	
		Early	C. striatus	
	Aptian		upper C. hughesi	
			lower C. hughesi	
	Barremian		F. wonthaggiensis	
	Hauterivian			
	Valanginian		upper C. australiensis	
	Berriasian		lower C. australiensis	
Juras.	Tithonian		R. watherooensis	

FIGURE 1 ZONATION FRAMEWORK

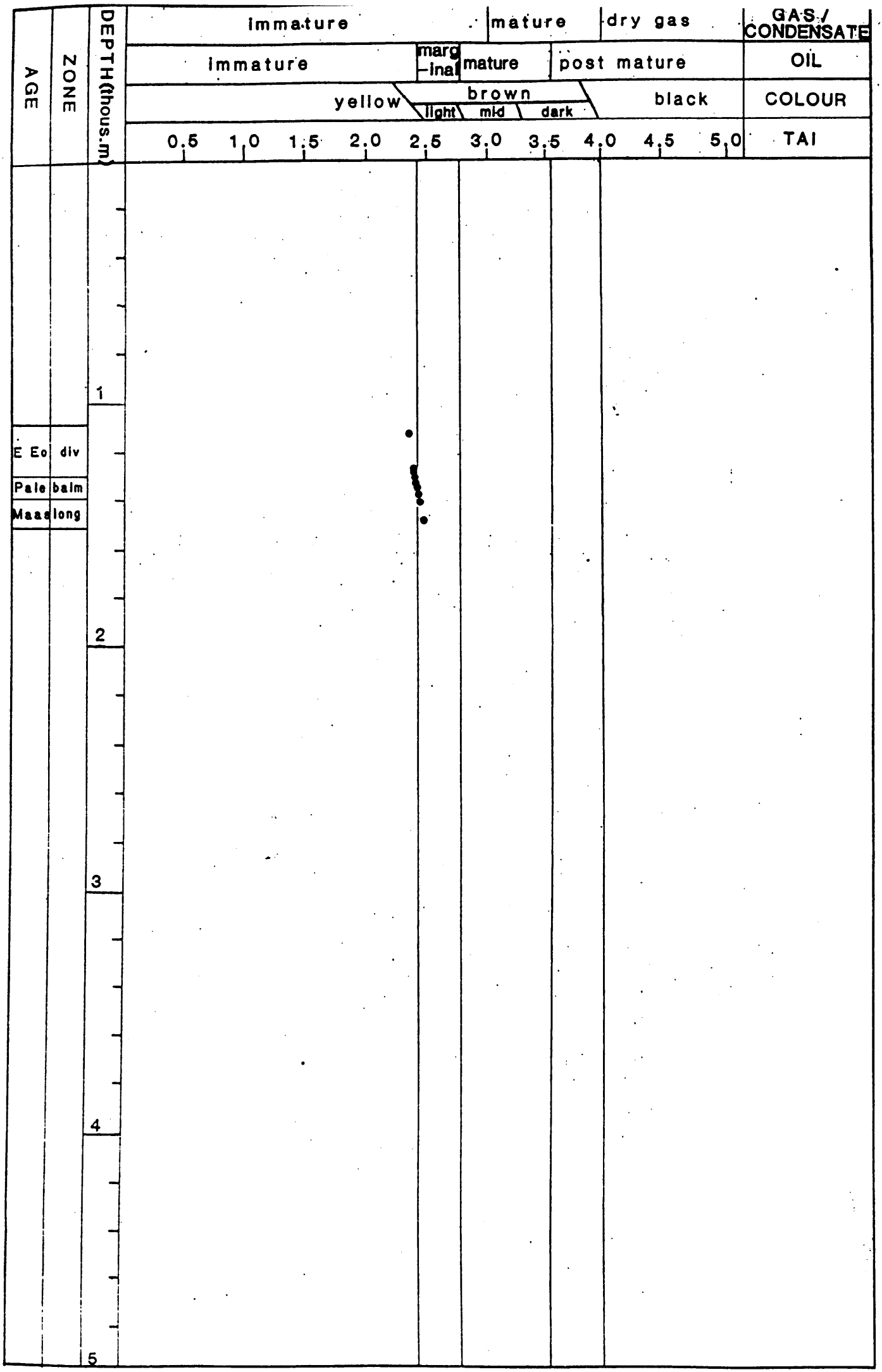

FIGURE 2 MATURITY PROFILE, HENKE-1

III PALYNOSTRATIGRAPHY

A. 1117m (swc) -1263m(swc) : upper M.diversus Zone

Assignment to the upper Malvacipollis diversus Zone is indicated at the top by the absence of younger indicators and at the base by oldest Proteacidites pachypolus. Proteacidites and Dilwynites dominate the assemblages, and the presence of Anacolosidites acutullus, Cyathidites gigantis, Proteacidites kopiensis and Triporopollenires ambiguus generally support the assignment. Minor Permian reworking was seen.

The dinoflagellates include Apectodinium homomorphum, Deflandrea obliquipes and Muratodinium fimbriatum but are not sufficient for clear dinoflagellate zonal assignment.

Nearshore marine environments are indicated at 1263m by the 25% dinoflagellate content and moderate diversity. Marginal marine environments are indicated at 1117m by the rare dinoflagellates and their low diversity.

Yellow spore colours indicate immaturity for hydrocarbons.

B. 1268m (swc) - 1285m (swc) : middle M.diversus Zone

Assignment to the middle Malvacipollis diversus Zone is indicated at the top by the absence of younger indicators, and at the base by oldest Anacolosidites acutullus. Banksieacidites arcuatus, and Triporopollenites ambiguus without older indicarors. Haloragacidites harrisii is the most common pollen seen. Dinoflagellates include Apectodinium homomorphum, Muratodinium fimbriatum, Deflandrea dartmooria and Hafniasphaera septata and are consistent with the spore pollen assignment, but not sufficient for clear dinoflagellate zonal assignment.

Nearshore marine environments are indicated by the frequent (30%) dinoflagellate content and moderate diversity. Leaf fragments and spores and pollen are very common.

Yellow spore colours indicate immaturity for hydrocarbons.

C. 1310m (swc) - 1321.5m (swc) : upper L.balmei Zone

Assignment to the upper Lygistepollenites balmei zone is indicated at the top by youngest Gambierina rudata, G edwardsii and Lygistepollenites balmei, and at the base by oldest Proteacidites incurvatus and P. grandis. Proteacidites and Gleicheniidites are the dominant forms.

The dinoflagellates seen are generally consistent with the spore pollen zonal assignment, but not sufficient for dinoflagellate zonal assignment.

Nearshore marine environments are indicated by high dinoflagellate contents (60% at 1310m, 50% at 1321.5m, 30% at 1318m), and moderate diversity. Spores and pollen are also common and diverse.

Yellow to yellow/brown spore colours indicate immaturity for hydrocarbon generation.

D. 1327.5m (swc) : lower L. balmei Zone (T. evittii Dinoflagellate Zone)

Assignment to the lower Lygistepollenites balmei Zone is indicated by the absence of younger or older indicators, and confirmed by the dinoflagellates. Spores and pollen are relatively scarce, swamped by the dinoflagellates.

Assignment to T. evittii Dinoflagellate Zone is indicated by the dominance of Palaeoperidinium pyrophorum in a moderately diverse assemblage which also included Deflandrea and Spinidinium spp.

Offshore marine environments are indicated by the dominance (90% of palynomorphs) of dinoflagellates and the scarcity of spores and pollen.

Yellow to yellow/brown spore colours indicate immaturity for hydrocarbon generation.

E. 1330m (swc) - 1430m (swc) : T.longus Zone

Assignment to the Tricolpites longus Zone is indicated at the top (1330m) on dinoflagellate evidence, confirmed at 1358m on youngest Quadraplanus brossus, Tricolpites confessus, T. longus , T. waiparaensis and Triporopollenites sectilis. At the base, zonal assignment is indicated by oldest Tetracolporites verrucosus and Tricolpites longus. Proteacidites and Dilwynites dominate the assemblages. Minor Eocene caving was seen at 1330m.

Age diagnostic dinoflagellates include Isabelidinium pellucidium and common Manumiella coronata at 1330m and 1344m and rare I. pellucidum, M. coronata and M. druggii at 1358m indicating assignment of these samples to the M. druggii dinoflagellate zone. The sample at 1430m lacks age diagnostic dinoflagellates and cannot be assigned to any zone. Nearshore marine environments are indicated at 1330m to 1358m, where frequent low diversity dinoflagellates occur. At 1430m, dinoflagellates are extremely scarce, and brackish environments are indicated.

Yellow /brown spore colours indicate marginal maturity for oil generation, and immaturity for gas/condensate generation.

IV CONCLUSIONS

A. Log picks are generally compatible with the palynology with two major exceptions.

The usual situation is for Pember Formation (upper L. balmei Zone at its base) to conformably overlie Pebble Point Formation (upper L. balmei Zone and coeval E. crassitabulata Dinoflagellate Zone) which then unconformably overlies Curdies or Paaratte Formation (Late Cretaceous T. longus Zone). In this well, the Pebble Point top and base log picks appear to be at 1320m and 1339.5m respectively (relying heavily on the PEF log).

This clearly suggest Pebble Point lithology at 1330m with a late Cretaceaus date. This is highly anomalous and may represent very heavy reworking (perhaps a fallen block from the fault scarp), sample mixup, or a new piece of geological knowledge. Examination of cuttings may eliminate the second possibility, while mounting regional knowledge may help to evaluate the other two.

This also clearly suggests that normal L. balmei Zone (E.crassitabulata Zone) section exists at this location (1320m - 1327m). There is scope to argue that the interval 1303m - 1320m may belong to the Pebble Point Formation on sonic and PEF response, but the lithology is certainly anomolous.

The presence of Pebble Point Formation of lower L. balmei (T. evitti) assignment is unusual as this Zone is not normally seen outside the Gippsland Basin. Its presence here and in Wilson - 1 suggests that it may be more common than previously recognised, and may represent Pebble Point Formation older than previously seen. Alternatively, it may represent a facies feature, with a background Pebble Point dinoflagellate assemblage, with the evittii Zone features superimposed under favourable facies conditions.

B. Environments are generally compatible with the regional picture, with the most marine intervals in the latest Cretaceous and Paleocene. The Eocene Dilwyn section in this location is significantly more marine than is often seen in the Otway Basin.

C. Maturity data indicate that the base of the drilled section is only marginally mature for oil. Deeper burial offstructure and the undrilled section could have provided suitable mature source rocks.

V REFERENCES

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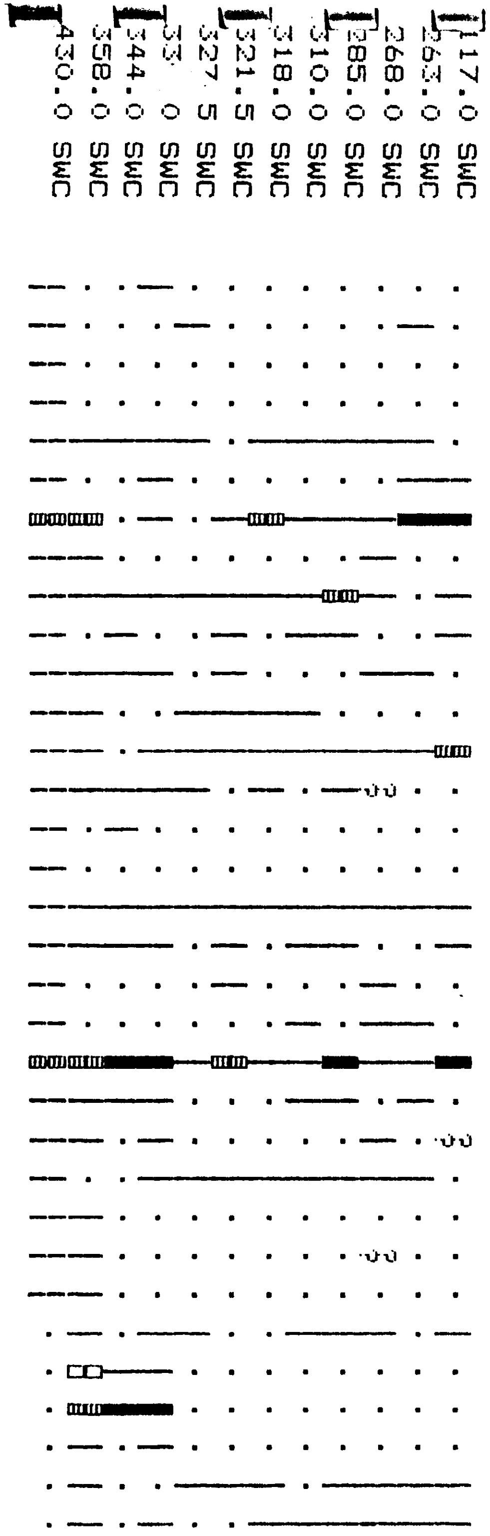
APPENDIX I

PALYNOMORPH OCCURRENCE DATA



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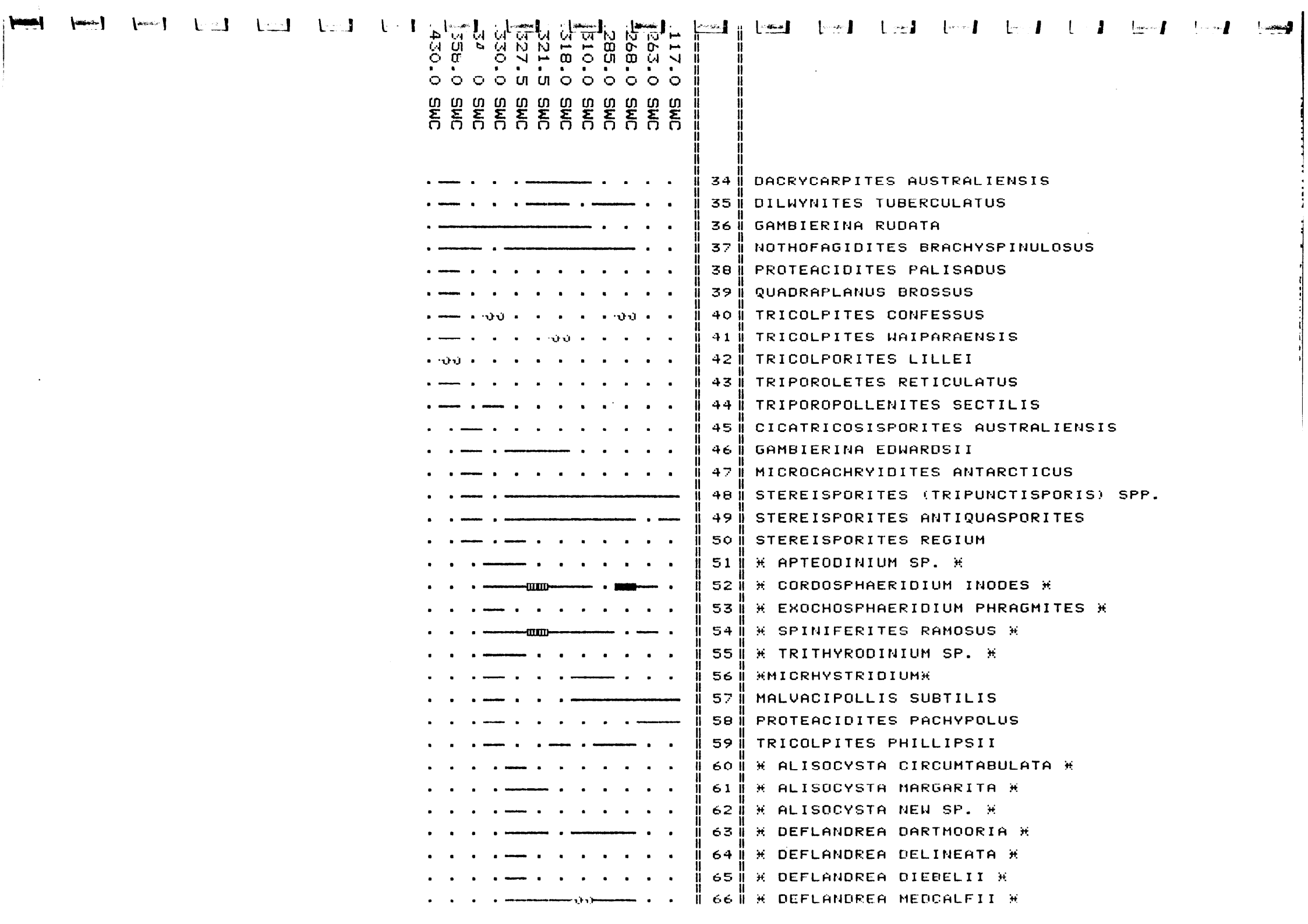
2 * PARALECANIELLA INDENTATA *
3 ANNULISPORITES FOLLICULOSA
4 CERATOSPORITES EQUALIS
5 CLAVIFERA TRIPLEX
6 CYATHIDITES SPP.
7 DILWYNITES GRANULATUS
8 FALCISPORITES SIMILIS
9 GLEICHENIIDITES
10 HERKOSPORITES ELLIOTTII
11 LATROBOSPORITES OHAIENSIS
12 LYGISTEPOLLENITES BALMEI
13 LYGISTEPOLLENITES FLORINII
14 NOTHOFAGIDITES ENDURUS
15 NOTHOFAGIDITES SENECTUS
16 OSMUNDACIDITES WELLMANII
17 PHYLOCLLADIDITES MAWSONII
18 PODOSPORITES MICROSACCATUS
19 PROTEACIDITES ADENANTHOIDES
20 PROTEACIDITES ANNULARIS
21 PROTEACIDITES SPP.
22 RETITRILETES AUSTROCLAVATIDITES
23 TETRACOLPORITES VERRUCOSUS
24 TRICOLPITES GILLII
25 TRICOLPITES LONGUS
26 TRICOLPITES SABULOSUS
27 TRICOLPITES SPP.
28 * BOTRYOCOCCUS *
29 * ISABELIDINIUM PELLUCIDUM *
30 * MANUMIELLA CORONATA *
31 * MANUMIELLA DRUGGII *
32 AUSTRALOPOLLIS OBSCURUS
33 CYATHIDITES SPLENDENS

= Abundant
= Common
= Few
= Rare
= Very Rare
= Questionably Present
= Not Present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321.5 SWC
327.5 SWC
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34 0 SWC
358.0 SWC
430.0 SWC
34 DACRYCARPITES AUSTRALIENSIS
35 DILWYNITES TUBERCULATUS
36 GAMBIERINA RUDATA
37 NOTHOFAGIDITES BRACHYSPINULOSUS
38 PROTEACIDITES PALISADUS
39 QUADRAPLANUS BROSSUS
40 TRICOLPITES CONFESSUS
41 TRICOLPITES WAIPARAENSIS
42 TRICOLPORITES LILLEI
43 TRIPOROLETES RETICULATUS
44 TRIPOROPOLLENITES SECTILIS
45 CICATRICOSISPORITES AUSTRALIENSIS
46 GAMBIERINA EDWARDSII
47 MICROCACHRYIDITES ANTARCTICUS
48 STEREISPORITES (TRIPUNCTISPORIS) SPP.
49 STEREISPORITES ANTIQUASPORITES
50 STEREISPORITES REGIUM
51 * APTEODINIUM SP. *
52 * CORDOSPHAERIDIUM INODES *
53 * EXOCHOSPHAERIDIUM PHRAGMITES *
54 * SPINIFERITES RAMOSUS *
55 * TRITHYRODINIUM SP. *
56 *MICRHYSTRIDIUM*
57 MALVACIPOLLIS SUBTILIS
58 PROTEACIDITES PACHYPOLUS
59 TRICOLPITES PHILLIPSII
60 * ALISOCYSTA CIRCUMTABULATA *
61 * ALISOCYSTA MARGARITA *
62 * ALISOCYSTA NEW SP. *
63 * DEFLANDREA DARTMOORIA *
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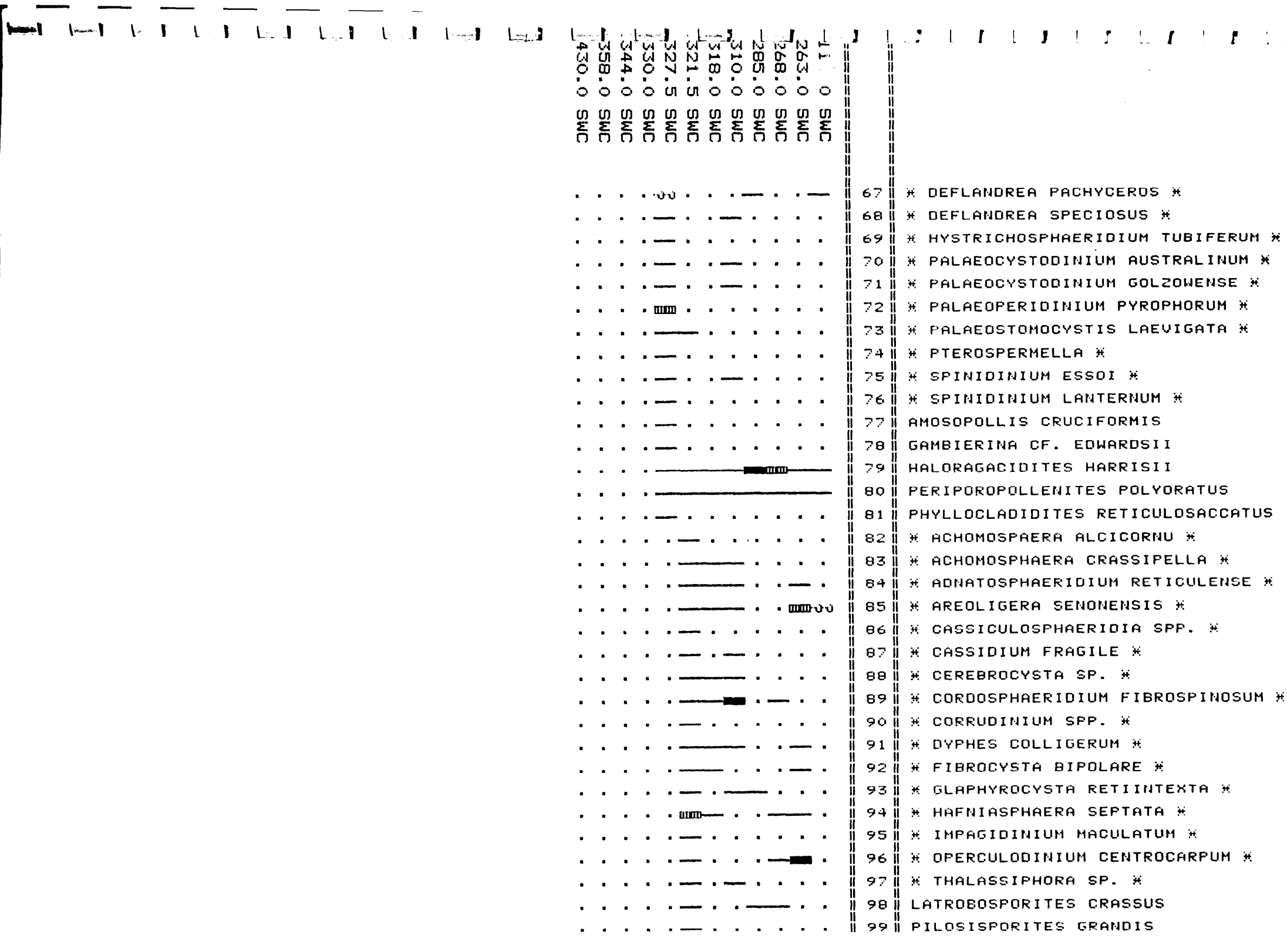
65 * DEFLANDREA DIEBELII *
66 * DEFLANDREA MEDCALFII *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310.0 SWC
318.0 SWC
321.5 SWC
327.5 SWC
330.0 SWC
344.0 SWC
358.0 SWC
430.0 SWC
67 * DEFLANDREA PACHYCEROS *
68 * DEFLANDREA SPECIOSUS *
69 * HYSTRICHOSPHAERIDIUM TUBIFERUM *
70 * PALAEOCYSTODINIUM AUSTRALINUM *
71 * PALAEOCYSTODINIUM GOLZOWENSE *
72 * PALAEOPERIDINIUM PYROPHORUM *
73 * PALAEOSTOMOCYSTIS LAEVIGATA *
74 * PTEROSPERMELLA *
75 * SPINIDINIUM ESSOI *
76 * SPINIDINIUM LANTERNUM *
77 AMOSOPOLLIS CRUCIFORMIS
78 GAMBIERINA CF. EDWARDSII
79 HALORAGACIDITES HARRISII
80 PERIPOROPOLLENITES POLYORATUS
81 PHYLLOCLADIDITES RETICULOSACCATUS
82 * ACHOMOSPAERA ALCICORNU *
83 * ACHOMOSPHAERA CRASSIPELLA *
84 * ADNATOSPHAERIDIUM RETICULENSE *
85 * AREOLIGERA SENONENSIS *
86 * CASSICULOSPHAERIDIA SPP. *
87 * CASSIDIUM FRAGILE *
88 * CEREBROCYSTA SP. *
89 * CORDOSPHAERIDIUM FIBROSPINOSUM *
90 * CORRUDINIUM SPP. *
91 * DYPHES COLLIGERUM *
92 * FIBROCYSTA BIPOLARE *
93 * GLAPHYROCYSTA RETIINTEXTA *
94 * HAFNIASPHAERA SEPTATA *
95 * IMPAGIDINIUM MACULATUM *
96 * OPERCULODINIUM CENTROCARPUM *
97 * THALASSIPHORA SP. *
98 LATROBOSPORITES CRASSUS
99 PILOSISPORITES GRANDIS

SPECIES LOCATION INDEX

ndex numbers are the columns in which species appear.

INDEX NUMBER	SPECIES
82	* ACHOMOSPAERA ALCICORNU *
83	* ACHOMOSPHAERA CRASSIPELLA *
134	* ACHOMOSPHAERA RAMULIFERA *
84	* ADNATOSPHAERIDIUM RETICULENSE *
60	* ALISOCYSTA CIRCUMTABULATA *
61	* ALISOCYSTA MARGARITA *
62	* ALISOCYSTA NEW SP. *
119	* APECTODINIUM HOMOMORPHA (L.) *
120	* APECTODINIUM HOMOMORPHA (SH.) *
121	* APECTODINIUM HYPERACANTHA *
122	* APECTODINIUM QUINQUELATA *
51	* APTEODINIUM SP. *
85	* AREOLIGERA SENONENSIS *
109	* AREOSPHAERIDIUM MULTICORNUTUM *
28	* BOTRYOCOCCUS *
86	* CASSICULOSPHAERIDIA SPP. *
87	* CASSIDIUM FRAGILE *
88	* CEREBROCYSTA SP. *
89	* CORDOSPHAERIDIUM FIBROSPINOSUM *
52	* CORDOSPHAERIDIUM INODES *
11	* CORDOSPHAERIDIUM MULTISPINOSUM *
90	* CORRUDINIUM SPP. *
138	* DAPSILIDINIUM PASTIELSII *
123	* DEFLANDREA CF. EXTENSA *
63	* DEFLANDREA DARTMOORIA *
64	* DEFLANDREA DELINEATA *

65 * DEFLANDREA DIEBELII *
103 * DEFLANDREA DILWYNENSIS *
66 * DEFLANDREA MEDCALFII *
45 * DEFLANDREA OBLIQUIPES *
67 * DEFLANDREA PACHYCEROS *
6 * DEFLANDREA SPECIOSUS *
24 * DEFLANDREA TRUNCATA *
91 * DYPHES COLLIGERUM *
111 * EOCLADOPYXIS PENICULATA *
53 * EXOCHOSPHAERIDIUM PHRAGMITES *
92 * FIBROCYSTA BIPOLARE *
104 * FIBROCYSTA VECTENSE *
93 * GLAPHYROCYSTA RETIINTEXTA *
125 * GLAPHYROCYSTA SP. *
94 * HAFNIASPHAERA SEPTATA *
1 * HETERAULACYSTA HETERACANTHUM *
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95 * IMPAGIDINIUM MACULATUM *
29 * ISABELIDINIUM PELLUCIDUM *
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3 * MANUMIELLA CORONATA *
31 * MANUMIELLA DRUGGII *
26 * MURATODINIUM FIMBRIATUM *
96 * OPERCULODINIUM CENTROCARPUM *
70 * PALAEOCYSTODINIUM AUSTRALINUM *
71 * PALAEOCYSTODINIUM GOLZOWENSE *
72 * PALAEOPERIDINIUM PYROPHORUM *
73 * PALAEOSTOMOCYSTIS LAEVIGATA *
2 * PARALECANIELLA INDENTATA *
74 * PTEROSPERMELLA *
75 * SPINIDINIUM ESSOI *
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54 * SPINIFERITES RAMOSUS *
114 * THALASSIPHORA PELAGICA *
97 * THALASSIPHORA SP. *
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12. * WETZELIELLA ARTICULATA *
56 *MICRHYSTRIDIUM*
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3 ANNULISPORITES FOLLICULOSA
32 AUSTRALOPOLLIS OBSCURUS
129 BANKSIEACIDITES ELONGATUS
4 CERATOSPORITES EQUALIS
45 CICATRICOSISPORITES AUSTRALIENSIS
5 CLAVIFERA TRIPLEX
139 CONVOLUTISPORA SPP.
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8 FALCISPORITES SIMILIS

78 GAMBIERINA CF EDWARDSII
46 GAMBIERINA EDWARDSII
36 GAMBIERINA RUDATA
105 GEPHRAPOLLENITES WAHOOENSIS
9 GLEICHENIIDITES
7[illegible] HALORAGACIDITES HARRISII
[illegible] HERKOSPORITES ELLIOTTII
116 INTRATRIPOROPOLLENITES NOTABILIS
131 ISCHYOSPORITES GREMIUS
98 LATROBOSPORITES CRASSUS
11 LATROBOSPORITES OHAIENSIS
12 LYGISTEPOLLENITES BALMEI
13 LYGISTEPOLLENITES FLORINII
141 MALVACIPOLLIS DIVERSUS
57 MALVACIPOLLIS SUBTILIS
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146 MYRTACEIDITES SPP.
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22 RETITRILETES AUSTROCLAVATIDITES
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27 TRICOLPITES SPP.

42 TRICOLPORITES LILLEI
49 TRICOLPORITES SPP.
43 TRIPOROLETES RETICULATUS
08 TRIPOROPOLLENITES AMBIGUUS
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3 VERRUCOSISPORITES KOPUKUENSIS