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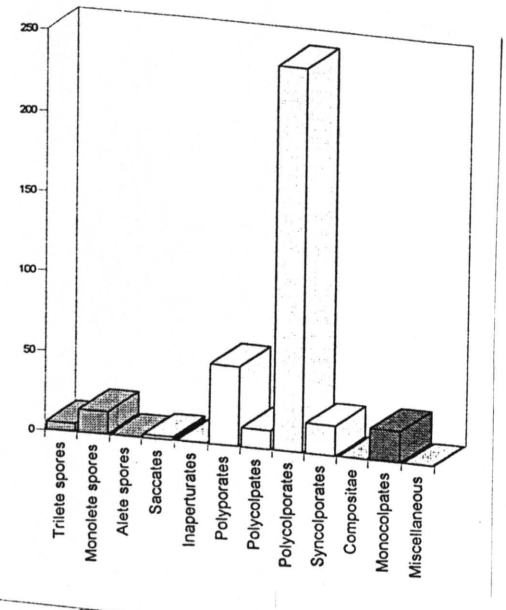
The palynology of tertiary sediments from a palaeochannel in Namaqualand

De Villiers, Susan E.

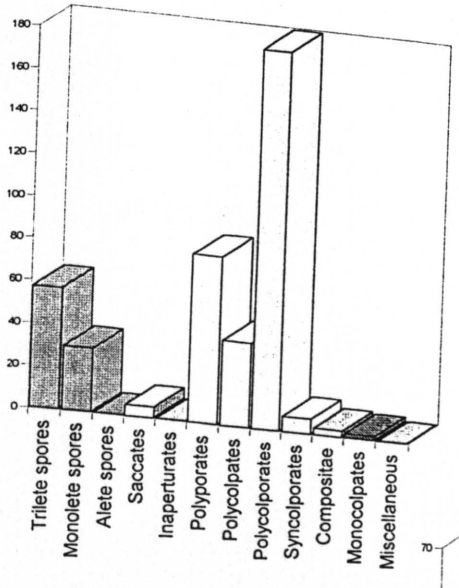
2013-09-02
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Pattern 1 (Sample 35-3)



Pattern 2 (sample 12-30)



Pattern 3 (Sample 12-23)

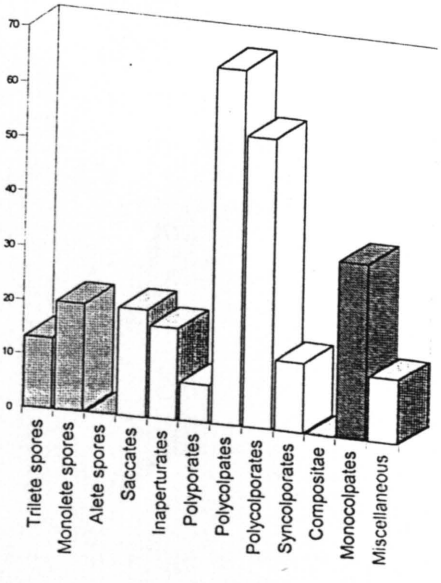
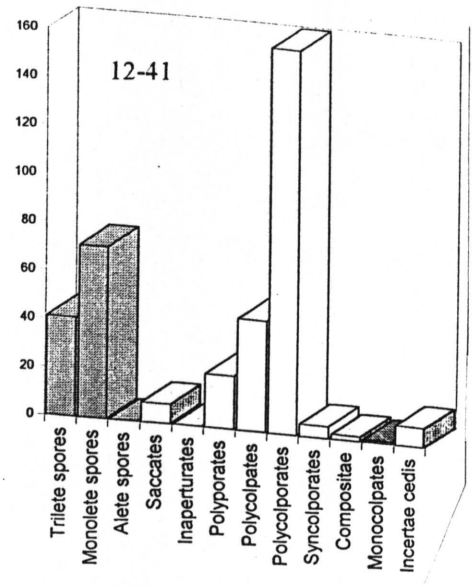
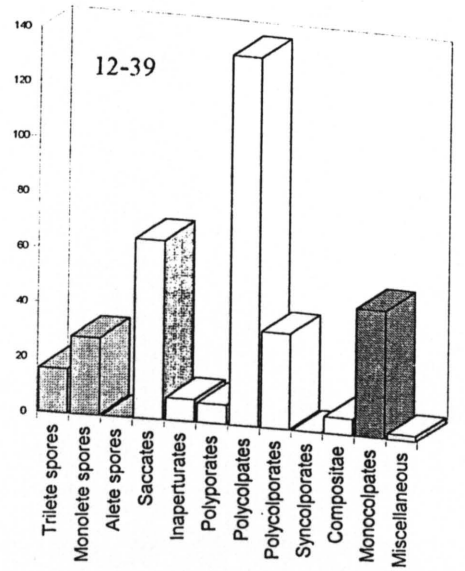


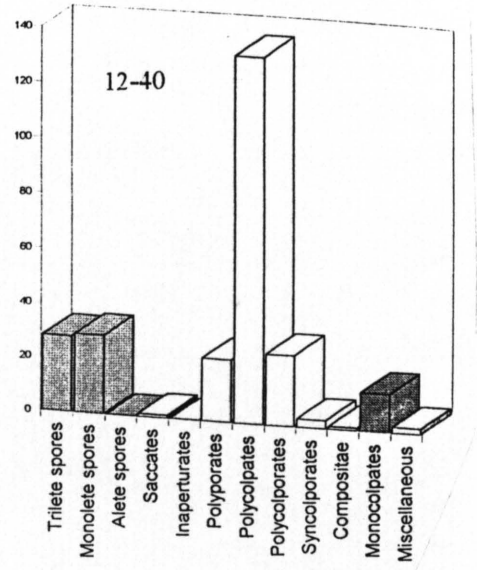
Figure 3.144 Comparison of typical palynoflora patterns.



Pattern 2



Pattern 3



Pattern 2

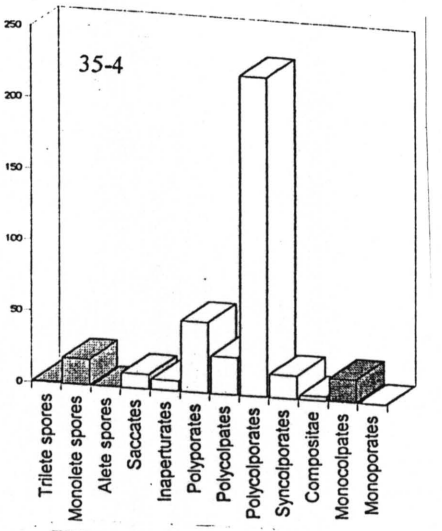
Figure 3.148

Comparison of sample assemblages

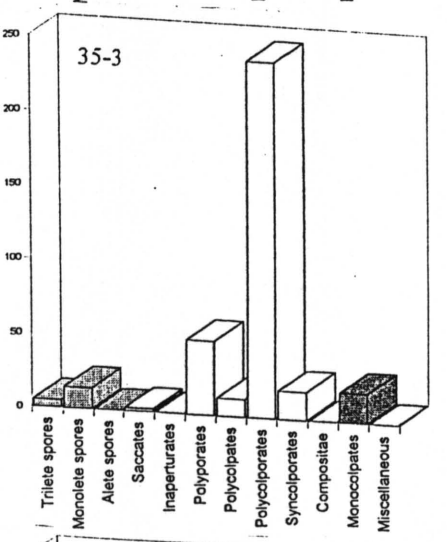
Koingnaas

Above Main Peat Horizon

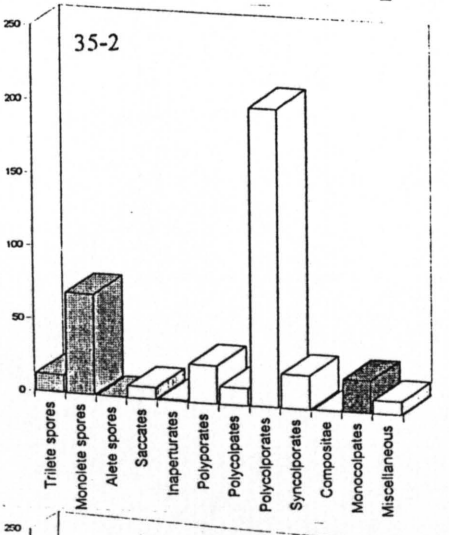
Approx stratigraphic section



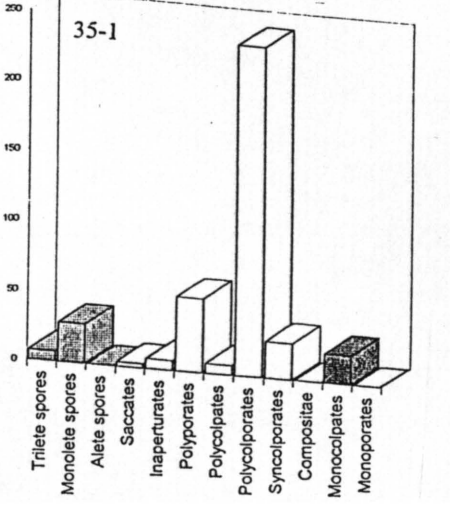
Pattern 1



Pattern 1



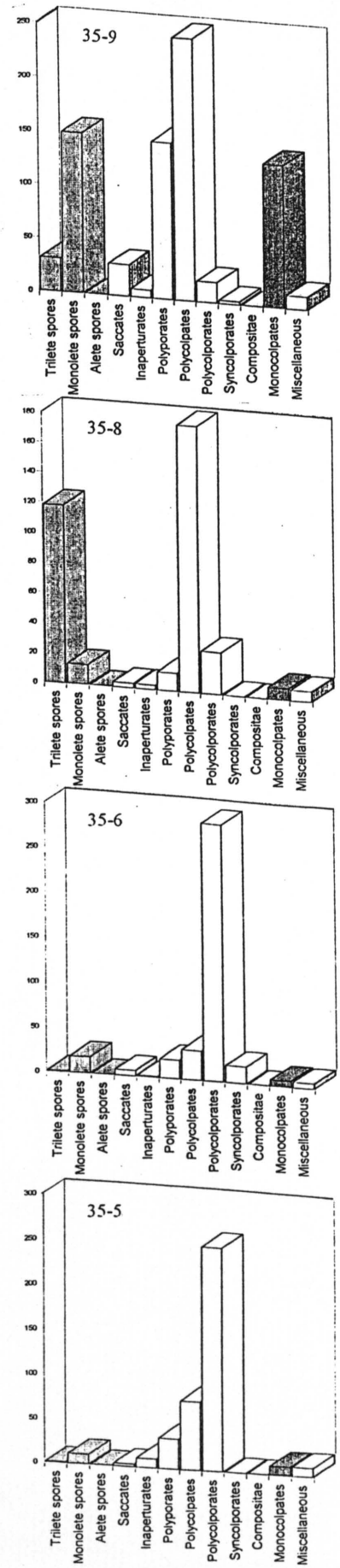
Pattern 1



Pattern 1

Figure 3.149

Comparison of sample assemblages
Langklip
Stratigraphic sequence through formation



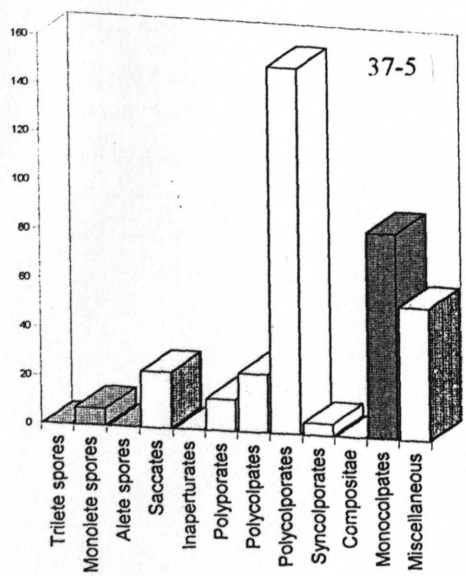
Pattern 3

Pattern 2

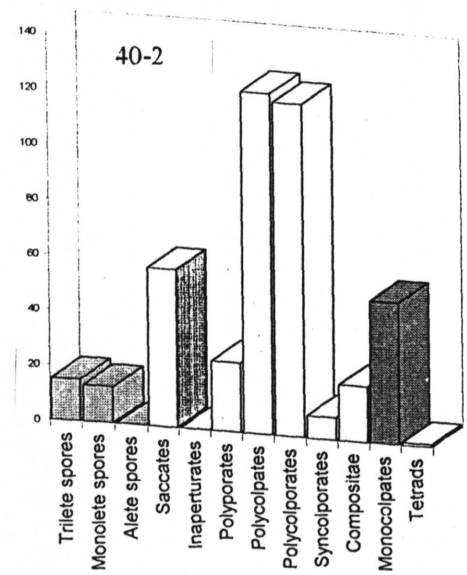
Pattern 1

Pattern 1

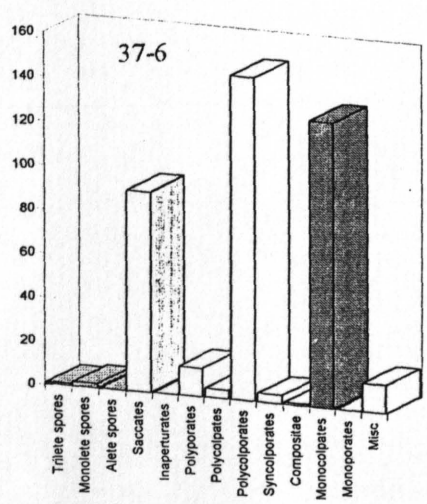
Figure 3.150 **Comparison of sample assemblages**
Langklip
Horizontal sampling across formation



Pattern 3



Pattern 3



Pattern 3

Figure 3.151 **Comparison of sample assemblages**
Somnaas/Noup

Table 3.1

Alphabetical listing of palynomorph types

Nomenclature	Form	Figure
Acaciapollenites sp	Polyad	3.133
Aglaoreidia sp	Monoporate pollen	3.44
Alisporites sp	Bisaccate pollen	3.36
Araucariacites sp	Inaperturate pollen	3.130
Arecipites sp	Monocolpate pollen	3.62
Byttneripollis sp	Stephanoporate pollen	3.58
Casuarinidites sp	Triporate pollen	3.45
Cicatricososporites sp	Monolete spore (striate)	3.32
Cretacaeiporites sp	Periporate pollen	3.59
Cricotriporites sp	Triporate pollen	3.46
Cupaniedites major	Syncolporate pollen	3.122
Cupaniedites orthoteichus	Syncolporate pollen	3.123
Cupuliferoidaepollenites sp	Tricolpate pollen	3.69
Cyathidites australis	Trilete spore (psilate)	3.12
Cyathidites minor	Trilete spore (psilate)	3.13
Cyathidites splendens	Trilete spore (psilate)	3.14
Deltoidospora sp	Trilete spore (psilate)	3.15
Dicotetradites sp	Tetrad	3.134
Dictyophyllidites sp	Trilete spore (psilate)	3.16
Echimonocolpites sp	Monocolpate pollen	3.63
Echinosporis sp	Monolete spore (echinate)	3.33
Echitricolpites sp	Tricolpate pollen	3.70
Echitriporites sp	Triporate pollen	3.47
Ephedripites sp	Stephanocolpate pollen	3.85
Ericipites sp	Tetrad	3.135
Foveotriletes sp	Trilete spore (foveolate)	3.23
Gemmatricolpites sp	Tricolpate pollen	3.71
Gemmatricolporites berbicensis	Tricolporate pollen	3.90
Gleicheniidites sp	Trilete spore (psilate)	3.17
Glencolpollis ornatus	Stephanocolpate pollen	3.86
Gothanipollis sp	Syncolporate pollen	3.124
Inaperturate pollen A	Inaperturate pollen	3.131
Incertae sedis A	Incertae sedis	3.136
Incertae sedis B	Incertae sedis	3.137
Interulobites sp	Trilete spore (cingulate)	3.5
Intratriporopollenites sp	Triporate pollen	3.48
Laevigatosporites sp	Monolete spore (psilate)	3.28
Liliacidites sp	Monocolpate pollen	3.64
Lygodiumsporites sp	Trilete spore (psilate)	3.18
Malvacipolloides sp	Tricolporate pollen	3.91
Margocolporites scabratus	Tricolporate pollen	3.92
Margocolporites sp	Tricolporate pollen	3.93
Microcachrydites antarcticus	Trisaccate pollen	3.41
Momipites sp	Triporate pollen	3.49
Monocolpopollenites sp	Monocolpate pollen	3.65
Myrtacidites oceanicus	Syncolporate pollen	3.125
Myrtacidites parvus	Syncolporate pollen	3.126
Osmundacidites wellmanii	Trilete spore (granulate)	3.22
Perinomonolites sp	Monolete spore (perinous)	3.25
Peromonolites bowenii	Monolete spore (perinous)	3.26

continued...

Peromonolites densus	Monolete spore (perinous)	3.27
Podocarpidites marwickii	Bisaccate pollen	3.37
Podocarpidites sp A	Bisaccate pollen	3.38
Podocarpidites sp B	Bisaccate pollen	3.39
Podocarpidites sp C	Bisaccate pollen	3.40
Polypodiaceoisporites retirugatus	Trilete spore (cingulate)	3.6
Polypodiaceoisporites cf *tumulatus*	Trilete spore (cingulate)	3.7
Polypodiaceoisporites sp A	Trilete spore (cingulate)	3.8
Polypodiaceoisporites sp	Trilete spore (cingulate)	3.9
Polypodiidites inangahuensis	Monolete spore (verrucate)	3.29
Polypodiisporites sp A	Monolete spore (verrucate)	3.30
Polypodiisporites sp	Monolete spore (verrucate)	3.31
Porosipollis sp	Syncolporate pollen	3.127
Propylipollis sp	Triporate pollen	3.50
Proteacidites sp	Triporate pollen	3.51
Retibrevitricolpites sp	Tricolpate pollen	3.72
Retimonocolpites sp	Monocolpate pollen	3.66
Retistephanocolporites sp	Stephanocolporate pollen	3.116
Retisyncolporites sp	Syncolporate pollen	3.128
Rhoipites sp A	Tricolporate pollen	3.95
Rhoipites sp B	Tricolporate pollen	3.96
Rhoipites sp C	Tricolporate pollen	3.97
Rhoipites sp D	Tricolporate pollen	3.98
Rhoipites sp E	Tricolporate pollen	3.99
Rhoipites sp F	Tricolporate pollen	3.100
Rhoipites sp G	Tricolporate pollen	3.101
Rhoipites sp H	Tricolporate pollen	3.102
Rhoipites sp J	Tricolporate pollen	3.103
Rhoipites sp K	Tricolporate pollen	3.104
Rhoipites sp L	Tricolporate pollen	3.105
Rhoipites sp	Tricolporate pollen	3.106
Sapotaceoidaepollenites sp	Stephanocolporate pollen	3.117
Simpsonipollis sp A	Tricolporate pollen	3.107
Simpsonipollis sp	Tricolporate pollen	3.108
Stephanocolpate pollen A	Stephanocolpate pollen	3.87
Stephanocolpate pollen B	Stephanocolpate pollen	3.88
Stephanocolporate pollen A	Stephanocolporate pollen	3.120
Stephanocolporate pollen B	Stephanocolporate pollen	3.121
Stephanocolporites sp	Stephanocolporate pollen	3.118
Stephanoporate pollen A	Stephanoporate pollen	3.55
Stephanoporate pollen B	Stephanoporate pollen	3.56
Stephanoporate pollen C	Stephanoporate pollen	3.57
Stereisporites subgenus *Cingutriletes* sp	Trilete spore (cingulate)	3.10
Striamonocolpites sp	Monocolpate pollen	3.67
Striatopollis sp	Tricolpate pollen	3.73
Tetracolporites sp	Stephanocolporate pollen	3.119
? *Tetraporina* sp	Stephanoporate pollen	3.54
Thymelipollis sp	Periporate pollen	3.60
Todisporites sp	Trilete spore (psilate)	3.19
Trichotomocolpate pollen	Trichotomocolpate pollen	3.68
Tricolpate pollen A	Tricolpate pollen	3.83
Tricolpate pollen B	Tricolpate pollen	3.84
Tricolpites alveolatus	Tricolpate pollen	3.74
Tricolpites asperamarginis	Tricolpate pollen	3.75
Tricolpites confessus	Tricolpate pollen	3.76
Tricolpites cooksonae	Tricolpate pollen	3.77
Tricolpites delicatulus	Tricolpate pollen	3.78

continued...

Tricolpites giganteus	Tricolpate pollen	3.79
Tricolpites gillii	Tricolpate pollen	3.80
Tricolpites sp cf. *micromunus*	Tricolpate pollen	3.81
Tricolpopollenites sp	Tricolpate pollen	3.82
Tricolporites sp	Tricolporate pollen	3.109
Tricolporate pollen A	Tricolporate pollen	3.115
Trilete spore A	Trilete spore (psilate)	3.21
Triorites sp	Triporate pollen	3.52
Triporate pollen A	Triporate pollen	3.53
Trisaccate pollen A	Trisaccate pollen	3.42
Tubulifloridites antipodica	Tricolporate pollen	3.110
Tubulifloridites viteauensis	Tricolporate pollen	3.111
Tubulifloridites sp A	Tricolporate pollen	3.112
Tubulifloridites sp	Tricolporate pollen	3.113
Undulatisporites sp	Trilete spore (psilate)	3.20
Verrucingulatisporites sp	Trilete spore (cingulate)	3.11
Verrutricolporites sp	Tricolporate pollen	3.114

tanical affinities

ily	Genus	Morphology	Climatic tolerance	Palynomorph
gnaceae	*?Sphagnum*	Peat moss. Forest floors & bogs	Humid	*Stereisporites subgen Cingutriletes*
taceae	*Pteris*	Mostly terrestrial. Scaly rhizomes		*Deltoidospora, Polypodiaceoisporites*
niaceae	*Asplenium*	Epiphytic, lithophytic or terrestrial		*Perinomonolites*
iaceae	*Athyrium*			*Perinomonolites*
noideae	*Blechnum*	Lithophytic, epiphytic	Tropical	*Laevigatosporites* *Perinomolites*
aceae		Tree ferns	Shady, moist conditions	*Cyathidites*
staediaceae	*Paesia*	Large terrestrial herbs		*Peromonolites*
oniaceae				*Cyathidites*
heniaceae	*Dictyophyllum*	Herbaceous, creeping rhizomes		*Deltoidospora, Gleicheniidites, Dictyophyllidites*
odiaceae	*Microsorium*	Terrestrial, epiphytic. Climb/creep	Tropical & temperate	*Polypodiidites, Polypodiisporites* *Polypodiidites*
aceae	*Schizaea* *Lygodium*	Creeping rhizomes with hairs or scales	Tropical	*Cicatricososporites, Laevigatosporites* *Lygodiumsporites*
ndaceae	*Todites*	Understorey. Creeping rhizomes	Tropical & temperate	*Osmundacidites* *Todisporites*
oglossaceae		Terrestrial herbs with globose/elongated rhizomes. Few fronds	Tropical & temperate	*Foveotriletes*
cariaceae		Forest trees	Tropical & subtropical	*Araucariacites*
carpaceae		Forest trees	Montane tropical	*Podocarpidites*

ily	Genus	Morphology	Climatic tolerance	Palynomorph
gnoliopsida (Dicotyledonous)				
anthaceae		Herbaceous	Tropical & subtropical	*Clavatipollenites*
aceae	*Corylus*	Trees or shrubs	Temperate	*Momipites, Propylipollis*
ceae	*Ficus, Alfo, Engelhardtia*	Trees, shrubs, lianas, rarely herbs	Tropical & subtropical	*Momipites, Propylipollis*
arinaceae		Evergreen trees & shrubs	Tropical & subtropical	*Casuarina*
onaceae		Herbs, shrubs, (lianas & trees)	Temperate	*Glencopollis ornatus*
ceae		Herbs, shrubs, small trees	Cosmopolitan (tropics)	*Malvaceipolloides*
eae		Trees, shrubs, rarely herbs	Tropical & subtropical	*Tiliapollenites*
eriaceae	*Byttneria*	Trees or shrubs	Tropical & subtropical	*Byttneripollis*
rbitaceae		Herbaceous - climb or trail	Tropical & subtropical	*Simpsonipollis*
aceae		Trees or shrubs	Tropical	*Sapotaceoidaepollenites*
idaceae		Shrubs or small trees	Subtropical & temperate	*Dicotetradities, Ericipites*
ceae		Evergreen shrubs	Subtropical & temperate	*Ericipites*
aceae		Evergreen shrubs and trees	Tropical & subtropical	*Proteacidites, Triorites*
elaceae		Shrubs or trees	Cosmopolitan	*Thymelipollis*
liaceae	*Ilex*	Shrubs or small trees	Cosmopolitan	*Gemmatricolpites*
eraceae	*Gunnera*	Megaphytic herbs	Moist, mild climates	*Tricolpites reticulatus*
ceae		Trees, shrubs, woody vines	Tropical & subtropical	*Rhoipites* sp A, C
ceae		Trees, shrubs, rarely herbs	Temperate	*Rhoipites* sp A, B
eae		Climbing, woody vines	Tropical & subtropical	*Rhoipites* sp A
eae		Trees or shrubs, rarely herbs	Tropical & subtropical	*Rhoipites* sp D
rdiaceae		Trees, shrubs or woody vines	Pantropical, temperate	*Simpsonipollis*
daceae		Trees, shrubs, vines	Tropical & subtropical	*Simpsonipollis, Cupaniedites*
		Trees, shrubs, herbs or vines	Cosmopolitan	*Simpsonipollis*
alaceae		Trees, shrubs, woody vines	Cosmopolitan	*Staphanocolporites*
ceae		Trees, shrubs, woody vines	Tropical & subtropical	? Stephanocolpate pollen A
aceae		Herbs or small shrubs	Coastal	*Simpsonipollis*
aceae (Compositae)		Herbs (rarely shrubs or trees)	Cosmopolitan	*Tubulifloridites*
opsida (Monocotyledonous)				
eae		Geophytic herbs	Cosmopolitan (Africa)	*Liliacidites*
ae		Geophytic herbs	Temperate to subtropical	*Liliacidites*
ae		Small to large herbs	Tropical & subtropical	*Liliacidites*
ceae		Slender trees, stout shrubs	Tropical, warm temperate	*Arecipites, Striamonocolpites*

Kolnghaas

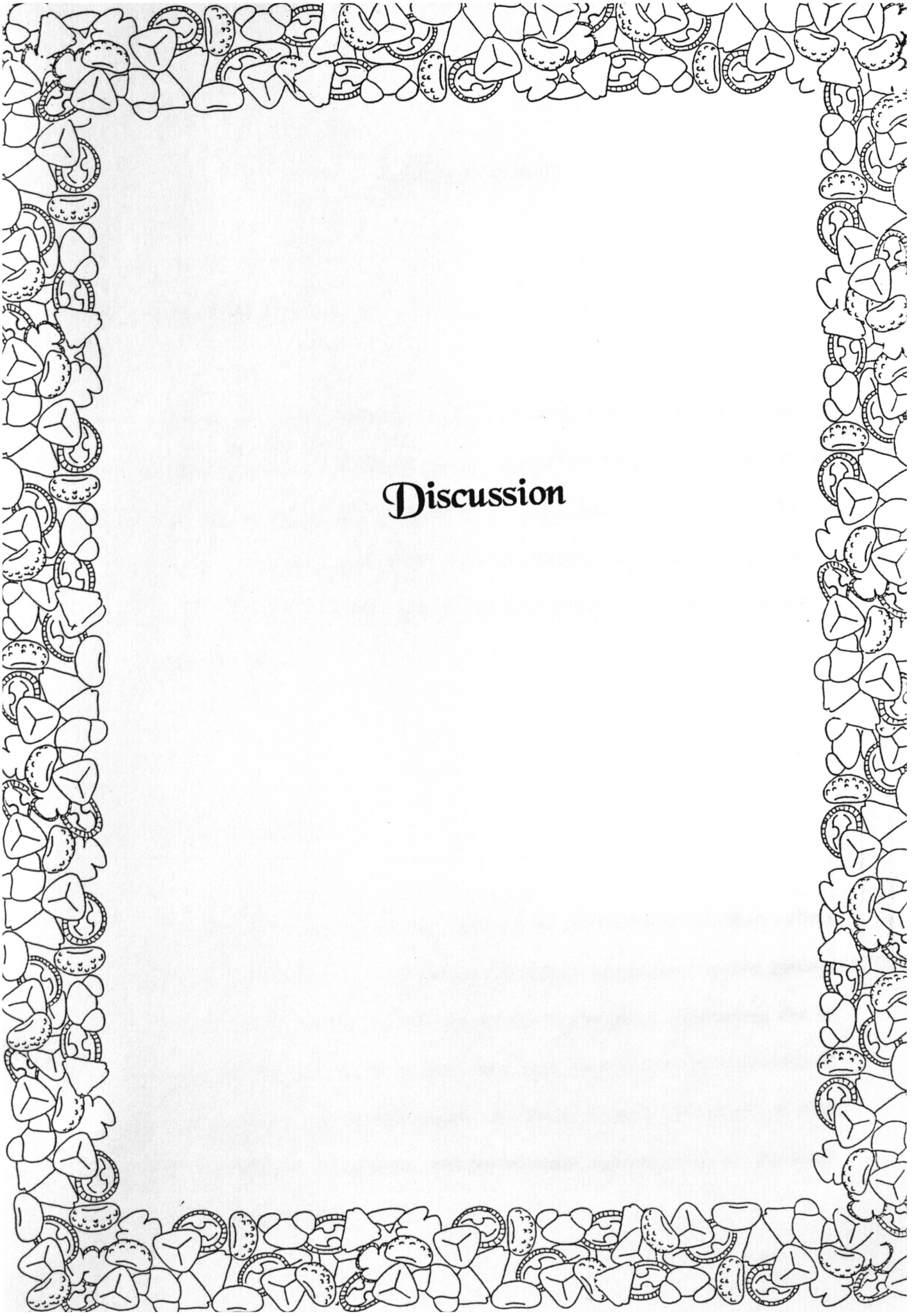
Paly'morph group	Genus	species	Channel Peat												(Zw)		Main Peat Horizon																		Above MPH					
			12;30	(%)	12;34	(%)	12;35	(%)	12;37	(%)	34-9	(%)	34-10	(%)	10;2	(%)	12;1	(%)	12;2	(%)	12;14	(%)	12;20	(%)	12;21	(%)	12;22	(%)	12;23	(%)	12;24	(%)	12;28	(%)	12;33	(%)	12;39	(%)	12;40	(%)	12;41	(%)
Spores Trilete																																								
Cingulate	*Interidobites*	sp															6	1.46	1	0.25																					
	Polypodiaceoisporites	*retirugatus*											1	0.27	1	0.43			14	3.45	3	0.52							1	0.38			1	0.39								
	Polypodiaceoisporites	*tumulatus*															17	4.13	1	0.25																	2	0.56				
	Polypodiaceoisporites	sp A																			2	0.35																			1	0.27
	Polypodiaceoisporites	sp			6	2.36			1	0.39			2	0.54			11	2.67			9	1.57											17	6.64	4	1.61	5	1.40			1	0.27
	Stereisporites subgen *Cingutriletes* sp				2	0.79	1	0.41					3	0.82																					1	0.40						
	Verrucingulatisporites	sp	2	0.50									3	0.82	1	0.43	3	0.73					2	0.47					1	0.39							4	1.52	5	1.33
Psilate	*Cyathidites*	*australis*	18	4.50	1	0.39					1	0.27	1	0.27			2	0.49			25	4.37	1	0.23	8	2.99	2	0.79	6	2.31	1	0.39	14	5.47	13	5.22					10	2.67
	Cyathidites	*minor*									12	3.23	8	2.17			1	0.24	4	0.99							13	5.16													
	Cyathidites	*splendens*	1	0.25																	1	0.17									3	1.17								
	Cyathidites	sp							10	3.89					18	7.73	22	5.34					5	1.17																
	Deltoidospora	sp			1	0.39	5	2.07					12	3.26	10	4.29	1	0.24	2	0.49	3	0.52													9	3.61	7	1.97			3	0.80
	Dictyophyllidites	sp			3	1.18					3	0.81					6	1.46	2	0.49					3	1.12	1	0.40					1	0.39				0.00			2	0.53
	Gleicheniidites	sp											6	1.63					4	0.99																				
	Lygodiumsporites	sp	36	9.00	1	0.39															190	33.22							5	1.92	17	6.64			4	1.61		19	7.22	20	5.33
	Todisporites	sp																	6	1.48																		4	1.52		
	Undulatisporites	sp																																	2	0.80				
	Trilete spore	A			3	1.18	1	0.41			1	0.27			5	2.15	13	3.16	2	0.49	4	0.70			7	2.61	1	0.40	2	0.77	1	0.39			10	4.02	2	0.56	1	0.38		
Granulate	*Osmundacidites*	*wellmanii*	1	0.25													2	0.49									46	18.25			1	0.39									
Foveolate	*Foveotriletes*	sp													1	0.43																1	0.39								
Spores Monolete																																								
Perinous	*Perinomonolites*	sp									3	0.81																											1	0.27
	Peromonolites	*bowenii*																					1	0.23															4	1.07
	Peromonolites	*densus*									2	0.54																			1	0.39							3	0.80
	Peromonolites	sp			4	1.57			7	2.72													2	0.47														1	0.38	3	0.80
Psilate	*Laevigatasporites*	sp	7	1.75			3	1.24	17	6.61	2	0.54	16	4.35	4	1.72	20	4.85	13	3.20	60	10.49	18	4.20	6	2.24	10	3.97	18	6.92	11	4.30	11	4.30	27	10.84	18	5.06	23	8.75	30	8.00
Verrucate	*Polypodiidites*	*inangahuensis*	22	5.50	6	2.36	1	0.41	2	0.78							6	1.46			29	5.07									9	3.52	5	1.95			2	0.56	2	0.76	29	7.73
	Polypodisporites	sp A	1	0.25													1	0.24																	1	0.40	1	0.28	2	0.76		
	Polypodisporites	sp									5	1.34	7	1.90	2	0.86	28	6.80			50	8.74	9	2.10	3	1.12			2	0.77	4	1.56			14	5.62	6	1.69				
Echinate	*Echinosporis*	sp									4	1.08																												
Rugulate	*Cicatricosisporites*	sp																			1	0.17																	1	0.27
Pollen Saccate																																								
Bisaccate	*Alisporites*	sp											1	0.27					1	0.25	1	0.17											2	0.78			1	0.28				
	Podocarpidites	*marwickii*					1	0.41					21	5.71	1	0.43			8	1.97					4	1.49			19	7.31							30	8.43			3	0.80
	Podocarpidites	sp A																					6	1.40					1	0.38									5	1.33
	Podocarpidites	sp B	1	0.25			1	0.41	2	0.78			20	5.43					1	0.25	1	0.17													4	1.61	24	6.74				
	Podocarpidites	sp C																																			2	0.56				
	Podocarpidites	sp	4	1.00	3	1.18	7	2.90					3	0.82	2	0.86	7	1.70	23	5.67	7	1.22											4	1.56					1	0.38		
Polysaccate	*Microcachryidites*	*antarcticus*																																			8	2.25				
	Trisaccate pollen	sp A																																			1	0.28				
Pollen Monoporate																																								
	Aglaoreidia	sp							1	0.39																														
Pollen Triporate																																								
	Casuarina	sp	3	0.75											2	0.86	1	0.24					3	0.70											1	0.40						
	Cricotriporites	sp	1	0.25					2	0.78					1	0.43	1	0.24									1	0.40					1	0.39							5	1.33
	Echitriporites	sp																																							
	Intratriporopollenites	sp							2	0.78																														
	Momipites	sp	1	0.25	1	0.39									3	1.29			1	0.25							1	0.40	1	0.38					1	0.40						
	Propylipollis	sp							1	0.39			1	0.27	20	8.58	10	2.43									1	0.40											6	1.60
	Proteacidites	sp	6	1.50	7	2.76	23	9.54	26	10.12	14	3.76	46	12.50	11	4.72	29	7.04	2	0.49	21	3.67	17	3.96	7	2.61	1	0.40	5	1.92	2	0.78	1	0.39	3	1.20	7	1.97	22	8.37		
	Triorites	sp	8	2.00							9	2.42	5	1.36	2	0.86			9	2.22			3	0.70	10	3.73					1	0.39	11	4.30							3	0.80
	Triporate	sp A											1	0.27																										
Pollen Stephanoporate																																								
	? Tetraporina	sp									1	0.27					1	0.24					2	0.47																
	Stephanoporate pollen	A																							1	0.37														
	Stephanoporate pollen	B			14	5.51	5	2.07			23	6.18																												
	Stephanoporate pollen	C							1	0.39	1	0.27					1	0.24							1	0.37	1	0.40											1	0.27
Pollen Periporate																																								
	Byttneripollites	sp	31	7.75	5	1.97			7	2.72	7	1.88			9	3.86	26	6.31					3	0.70	5	1.87	3	1.19	1	0.38	20	7.81	1	0.39			1	0.28	1	0.38	10	2.67
	Cretacaeipollenites	sp	25	6.25																			15	3.50																
	Thymelipollis	sp											1	0.27							4	0.70			1	0.37														
Pollen Monocolpate																																								
	Arecipites	sp	1	0.25							2	0.54	3	0.82					4	0.99					2	0.75	1	0.40									15	4.21				
	Echimonocolpites	sp															1	0.24																			1	0.28				
	Liliacidites	sp											2	0.54			1	0.24	20	4.93					1	0.37	8	3.17	30	11.54							26	7.30	14	5.32		
	Monocolpopollenites	sp	1	0.25							2	0.54	7	1.90					22	5.42	10	1.75	2	0.47	1	0.37									1	0.40	2	0.56			1	0.27
	Retimonocolpites	sp																																						

																																			1	0.28				
											2	0.54			1	0.24	20	4.93					1	0.37	8	3.17	30	11.54							26	7.30	14	5.32		
	Monocolpopollenites	sp	1	0.25							2	0.54	7	1.90					22	5.42	10	1.75	2	0.47	1	0.37									1	0.40	2	0.56			1	0.27
	Retimonocolpites	sp																																								
	Striamonocolpites	sp							1	0.39	1	0.27									1	0.17							1	0.38							3	0.84				
Pollen Trichotomocolpate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Trichotomocolpate pollen														1	0.43			1	0.25					1	0.37																
Pollen Tricolpate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Capuliferoidaepollenites	sp	21	5.25	8	3.15			13	5.06	35	9.41			2	0.86					6	1.05	4	0.93			6	2.38					22	8.59	8	3.21						
	Echitricolpites	sp																																								
	Gemmatricolpites	sp	2	0.50																					2	0.75											1	0.28				
	Retibrevitricolpites										5	1.34	1	0.27									1	0.23			1	0.40														
	Striatopollis	sp	2	0.50					1	0.39									2	0.49					4	1.49									5	2.01						
	Tricolpites	*alveolatus*	1	0.25																			1	0.23					7	2.69							2	0.56	2	0.76		
	Tricolpites	*aspermarginis*	1	0.25							1	0.27							13	3.20													2	0.78			1	0.28	1	0.38		
	Tricolpites	*confessus*									3	0.81					3	0.73							4	1.49							1	0.39					5	1.90		
	Tricolpites	*cooksonae*									2	0.54							2	0.49	2	0.35									1	0.39			6	2.41	6	1.69				
	Tricolpites	*delicatulus*									7	1.88					1	0.24	2	0.49																						
	Tricolpites	*giganteus*																											6	2.31											1	0.27
	Tricolpites	*gillii*					1	0.41			1	0.27	2	0.54							9	1.57			27	10.07	9	3.57	8	3.08	3	1.17	1	0.39	6	2.41	11	3.09	32	12.17	12	3.20
	Tricolpites	*micromurus*	10	2.50	69	27.17	40	16.60	8	3.11	32	8.60	36	9.78	1	0.43	1	0.24	145	35.71	56	9.79	121	28.21	19	7.09	8	3.17	18	6.92	11	4.30	16	6.25	30	12.05	109	30.62	89	33.84	40	10.67
	Tricolpopollenites	sp	3	0.75	6	2.36	5	2.07	1	0.39	7	1.88	8	2.17			24	5.83	51	12.56	17	2.97	9	2.10	58	21.64	1	0.40	30	11.54	2	0.78			25	10.04			7	2.66		
	Tricolpate	A													1	0.43																										
	Tricolpate	B																							1	0.37																
Pollen Stephanocolpate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ephedripites	sp																																								
	Glencopollis	*ornatus*									1	0.27							4	0.99					3	1.12																
	Stephanocolpate	A																																			1	0.28				
	Stephanocolpate pollen	B																			2	0.35															4	1.12				
	Other stephanocolpate pollen																														1	0.39										
Pollen Tricolporate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Gemmatricolporites	*berbicensis*	4	1.00													3	0.73											3	1.15											5	1.33
	Malvacipolloides	sp					1	0.41																																		
	Margocolporites	*scabratus*	3	0.75			1	0.41	1	0.39					1	0.43																										
	Margocolporites	sp			2	0.79					3	0.81																												0.00		
	Rhoipites	A							1	0.39	3	0.81	2	0.54	1	0.43							4	0.93	1	0.37	1	0.40			2	0.78										
	Rhoipites	B			2	0.79	6	2.49			1	0.27	16	4.35			10	2.43					3	0.70			2	0.79													2	0.53
	Rhoipites	C			1	0.39	2	0.83			41	11.02	5	1.36	2	0.86							11	2.56	3	1.12															6	1.60
	Rhoipites	D	1	0.25	5	1.97											2	0.49					2	0.47									2	0.78					2	0.76		
	Rhoipites	E	13	3.25	10	3.94	24	9.96	7	2.72	8	2.15	3	0.82			29	7.04									1	0.40	1	0.38	1	0.39										
	Rhoipites	F	5	1.25							20	5.38	1	0.27	2	0.86	6	1.46					2	0.47	1	0.37			12	4.62	1	0.39			2	0.80	3	0.84			14	3.73
	Rhoipites	G	1	0.25							36	9.68	1	0.27					1	0.25							1	0.40					1	0.39			1	0.28	1	0.38		
	Rhoipites	H			13	5.12							17	4.62			1	0.24					2	0.47							4	1.56									12	3.20
	Rhoipites	J			1	0.39					4	1.08	1	0.27	1	0.43							3	0.70					2	0.77	3	1.17										
	Rhoipites	K			7	2.76	4	1.66			4	1.08	17	4.62	18	7.73	22	5.34					2	0.47					5	1.92	2	0.78									16	4.27
	Rhoipites	L			8	3.15					1	0.27			1	0.43							11	2.56			3	1.19			3	1.17									18	4.80
	Rhoipites	sp	94	23.50	4	1.57	58	24.07	93	36.19	48	12.90	52	14.13	27	11.59	49	11.89	4	0.99	28	4.90	108	25.17	4	1.49	60	23.81	15	5.77	47	18.36	127	49.61	13	5.22	29	8.15	17	6.46	77	20.53
	Simpsonipollis	sp A																							1	0.37					2	0.78	5	1.95							1	0.27
	Simpsonipollis	sp					3	1.24	6	2.33																			5	1.92									1	0.38		
	Tricolporites	sp	34	8.50	39	15.35	26	10.79	34	13.23			18	4.89	58	24.89					1	0.17			13	4.85	51	20.24	13	5.00	60	23.44							5	1.90		
	Tubulifloridites	*antipodica*																	36	8.87																					1	0.27
	Tubulifloridites	*viteauensis*																					1	0.23																		
	Tubulifloridites	sp A																																							1	0.27
	Tubulifloridites	sp	3	0.75			1	0.41																													6	1.69	1	0.38		
	Verrutricolporites	sp													1	0.43																										
	Tricolporate pollen	A	16	4.00	8	3.15	16	6.64	5	1.95					2	0.86	24	5.83			3	0.52	36	8.39	11	4.10	1	0.40	1	0.38	4	1.56			7	2.81	2	0.56			4	1.07
Pollen Stephanocolporate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Retistephanocolporites	sp			1	0.39			2	0.78													1	0.23							2	0.78					3	0.84				
	Sapotaceoidaepollenites	sp	1	0.25							4	1.08	2	0.54	2	0.86	15	3.64					2	0.47			1	0.40			4	1.56									2	0.53
	Stephanocolporites	sp	7	1.75	11	4.33	1	0.41															5	1.17																		
	Tetracolporites	sp	1	0.25																																					1	0.27
	Stephanocolporate	A																																							2	0.53
	Stephanocolporate	B							1	0.39																																
Pollen Syncolporate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Cupanieidites	*major*							4	1.56			5	1.36	2	0.86	1	0.24	1	0.25			7	1.63	2	0.75																
	Cupanieidites	*orthoteichus*	1	0.25							1	0.27	2	0.54	1	0.43	2	0.49																								
	Cupanieidites	sp	6	1.50	2	0.79	2	0.83			2	0.54			1	0.43	2	0.49	2	0.49	1	0.17	4	0.93			3	1.19	13	5.00	4	1.56	9	3.52	1	0.40			3	1.14	4	1.07
	Gothanipollis	sp																	1	0.25																						
	Myrtaceidites	*oceanicus*													1	0.43																										
	Myrtaceidites	*parvus*									1	0.27							1	0.25					1	0.37																
	Porosipollis	sp																																								
	Retisyncolporites	sp					2	0.83			8	2.15					1	0.24																							1	0.27
Pollen Inaperturate			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Araucariacites	sp											4	1.09			5	1.21	1	0.25					21	7.84			17	6.54					1	0.40	10	2.81				
	Inaperturate pollen	A											3	0.82																												
Pollen Tetrads/Polyads			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Acaciapollenites	sp																																								
	Dicotetradites	sp																																					1	0.38		
	Ericipites	sp																																								
Incertae sedis			.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Incertae sedis A												2	0.54	11	4.72			x		25	4.37			31	11.57	13	5.16	12	4.62	27	10.55			50	20.08	x	x	1	0.38	8	2.13
	Incertae sedis B																																									

			Langklip																Somnaas/Noup						Totals					
Paly'morph group	**Genus**	**species**	35-1	(%)	35-2	(%)	35-3	(%)	35-4	(%)	35-5	(%)	35-6	(%)	35-8	(%)	35-9	(%)	37-5	(%)	37-6	(%)	40-2	(%)	**Paly'morph group**	**Genus**	**species**	Total	G Tot		Stndrd	(Total)
Spores Trilete																									**Spores** Trilete				1022	1022		228
Cinguiate	*Interlobites*	*sp*																								*Interlobites*	*sp*	7			7	
	Polypodiaceoisporites	*retirugatus*	1	0.21	9	2.09																	1	0.22		*Polypodiaceoisporites*	*retirugatus*	32			22	
	Polypodiaceoisporites	*tumulatus*															1	0.13								*Polypodiaceoisporites*	*tumulatus*	21			8	
	Polypodiaceoisporites	*sp A*	3	0.64			2	0.46															1	0.22		*Polypodiaceoisporites*	*sp A*	9			9	
	Polypodiaceoisporites	*sp*	2	0.43			2	0.46							1	0.27	20	2.57								*Polypodiaceoisporites*	*sp*	81			12	
	Stereisporites **subgen** *Cingutriletes* **sp**																								**Cinguiate**	*Stereisporites* **subgen** *Cingutriletes* **sp**		7			3	
	Verrucingulatisporites	*sp*					1	0.23																		*Verrucingulatisporites*	*sp*	22			12	
	Cyathidites	*australis*	3	0.64	2	0.46									4	1.08							8	1.77		*Cyathidites*	*australis*	119			23	
	Cyathidites	*minor*															3	0.39								*Cyathidites*	*minor*	38			15	
	Cyathidites	*splendens*																								*Cyathidites*	*splendens*	5			5	
	Cyathidites	*sp*									1	0.25											5	1.11		*Cyathidites*	*sp*	61			0	
	Deltoidospora	*sp*					2	0.46	1	0.24			1	0.25	7	1.89										*Deltoidospora*	*sp*	60			20	
	Dictyophyllidites	*sp*					1	0.23																		*Dictyophyllidites*	*sp*	24			20	
	Gleicheniidites	*sp*																					2	0.44		*Gleicheniidites*	*sp*	10			12	
	Lygodiumsporites	*sp*													108	29.11										*Lygodiumsporites*	*sp*	400			14	
	Todisporites	*sp*																								*Todisporites*	*sp*	10			10	
	Undulatisporites	*sp*																								*Undulatisporites*	*sp*	2			2	
	Trilete spore	*A*	1	0.21	1	0.23											6	0.77								**Trilete spore**	*A*	61			25	
Granulate	*Osmundacidites*	*wellmanii*																							**Granulate**	*Osmundacidites*	*wellmanii*	51			7	
Foveolate	*Foveotriletes*	*sp*																			1	0.24			**Foveolate**	*Foveotriletes*	*sp*	2			2	
Spores Monolete																									**Spores** Monolete				938	938		144
Perinous	*Perinomonolites*	*sp*																							**Perinous**	*Perinomonolites*	*sp*	4			2	
	Peromonolites	*bowerii*			1	0.23																				*Peromonolites*	*bowerii*	6			6	
	Peromonolites	*densus*																								*Peromonolites*	*densus*	6			9	
	Peromonolites	*sp*			10	2.32			2	0.47																*Peromonolites*	*sp*	29			0	
Psilate	*Laevigatosporites*	*sp*	20	4.26	28	6.50	13	2.99	8	1.90	8	1.97	10	2.50	6	1.62	26	3.34	7	1.72	1	0.24	10	2.21	**Psilate**	*Laevigatosporites*	*sp*	451			44	
Verrucate	*Polypoditidites*	*inangahuensis*																							**Verrucate**	*Polypoditidites*	*inangahuensis*	113			14	
	Polypodisporites	*sp A*			1	0.23											22	2.83								*Polypodisporites*	*sp A*	29			8	
	Polypodisporites	*sp B*	1	0.21	29	6.73	1	0.23	8	1.90	3	0.74	8	2.00	7	1.89	101	12.98			1	0.24	3	0.66		*Polypodisporites*	*sp*	292			55	
Echinate	*Echinosporis*	*sp*																							**Echinate**	*Echinosporis*	*sp*	5			3	
Rugulate	*Cicatricosisporites*	*sp*																							**Rugulate**	*Cicatricosisporites*	*sp*	3			3	
Pollen Saccate																									**Pollen** Saccate				466	466		91
Bisaccate	*Alisporites*	*sp*							1	0.24															**Bisaccate**	*Alisporites*	*sp*	53			10	
	Podocarpidites	*marwickii*	2	0.43			2	0.46	7	1.66							1	0.13			46	11.19				*Podocarpidites*	*marwickii*	110			35	
	Podocarpidites	*sp A*	1	0.21																	11	2.68				*Podocarpidites*	*A*	15			7	
	Podocarpidites	*sp B*							2	0.47											2	0.49				*Podocarpidites*	*B*	110			27	
	Podocarpidites	*sp C*															20	2.57			32	7.79	2	0.44		*Podocarpidites*	*sp C*	3			3	
	Podocarpidites	*sp*			8	1.86					3	0.74	6	1.50	3	0.81	1	0.13								*Podocarpidites*	*sp*	165			0	
Polysaccate	*Microcachryidites*	*antarcticus*															7	0.90	23	5.64			54	11.95	**Polysaccate**	*Microcachryidites*	*antarcticus*	8			7	
	Trisaccate pollen	*sp A*																					1	0.22		**Trisaccate pollen**	*sp A*	2			2	
Pollen Monoporate																									**Pollen** Monoporate				1	1037		1
	Aglaoreidia	*sp*																								*Aglaoreidia*	*sp*	1			1	
Pollen Triporate																									**Pollen** Triporate				742			132
	Casuarina	*sp*			1	0.23																	3	0.66		*Casuarina*	*sp*	15			4	
	Cricotriporites	*sp*	2	0.43	2	0.46	1	0.23									1	0.13			2	0.49				*Cricotriporites*	*sp*	19			13	
	Echitriporites	*sp*	1	0.21																						*Echitriporites*	*sp*	1			1	
	Tiliaepollenites	*sp*																								*Tiliaepollenites*	*sp*	4			2	
	Momipites	*sp*			1	0.23																				*Momipites*	*sp*	8			8	
	Propylipollis	*sp*			1	0.23	3	0.69	21	4.98													1	0.22		*Propylipollis*	*sp*	65			9	
	Proteacidites	*sp*	38	8.10	21	4.87	40	9.20	12	2.84	4	0.98	12	3.00	5	1.35	142	18.25	6	1.47	3	0.73	20	4.42		*Proteacidites*	*sp*	553			74	
	Triorites	*sp*	8	1.71			5	1.15							7	1.89	3	0.39	6	1.47	1	0.24				*Triorites*	*sp*	91			20	
	Triporate	*sp A*																								**Triporate**	*sp A*	1			1	
Pollen Stephanoporate																									**Pollen** Stephanoporate				91			19
	? Tetraporina	*sp*																								*? Tetraporina*	*sp*	4			2	
	Stephanoporate pollen	*A*							8	1.90	15	3.69	9	2.25												**Stephanoporate pollen**	*A*	35			10	
	Stephanoporate pollen	*B*	3	0.64																	1	0.24	1	0.22		**Stephanoporate pollen**	*B*	46			2	
	Stephanoporate pollen	*C*																					1	0.22		**Stephanoporate pollen**	*C*	6			5	
Pollen Periporate																									**Pollen** Periporate				203			58
	Byttneripollis	*sp*							8	1.90	15	3.69														*Byttneripollis*	*sp*	155			40	
	Cretacaepollenites	*sp*																	1	0.25	1	0.24				*Cretacaepollenites*	*sp*	40			12	
	Thymelipollis	*sp*	1	0.21			1	0.23																		*Thymelipollis*	*sp*	8			6	
Pollen Monocolpate																									**Pollen** Monocolpate				594	3131		107
	Arecipites	*sp*	4	0.85	10	2.32	17	3.91	5	1.18	5	1.23														*Arecipites*	*sp*	69			11	
	Echimonocolpites	*sp*	1	0.21																						*Echimonocolites*	*sp*	3			3	
	Liliacidites	*sp*	10	2.13	6	1.39	1	0.23	6	1.42			2	0.50			6	0.77	84	20.59	129	31.39	9	1.99		*Liliacidites*	*sp*	355			45	
	Monocolpopollenites	*sp*	6	1.28	6	1.39	2	0.46	5	1.18			3	0.75	6	1.62	104	13.37	1	0.25	3	0.73	42	9.29		*Monocolpopollenites*	*sp*	127			18	
	Clavatipollenites	*sp*									1	0.25			2	0.54	14	1.80								*Clavatipollenites*	*sp*	17			12	
	Striamonocolpites	*sp*	1	0.21							4	0.98	2	0.50			9	1.16						0.00		*Striamonocolpites*	*sp*	23			18	
Pollen Trichotomocolpate																									**Pollen** Trichotomocolpate							3
	Trichotomocolpate pollen																						1	0.22		**Trichotomocolpate**	*A*	4			3	
Pollen Tricolpate																									**Pollen** Tricolpate				2520			252
	Cupuliferoidaepollenites	*sp*	4	0.85	1	0.23									3	0.81	10	1.29	1	0.25	3	0.73	2	0.44								

	[illegible]	sp	1	0.21							4	0.98	2	0.50			9	1.16						0.00
Pollen Trichotomocolpate																								
	Trichotomocolpate pollen																						1	0.22
Pollen Tricolpate																								
	Cupuliferoidaepollenites	sp	4	0.85	1	0.23									3	0.81	10	1.29	1	0.25	3	0.73	2	0.44
	Echitricolpites	sp																					1	0.22
	Gemmatricolpites	sp																						
	Retibrevitricolpites																							
	Striatopollis	sp	1	0.21					6	1.42	4	0.98			9	2.43	16	2.06					1	0.22
	Tricolpites	*alveolatus*											7	1.75										
	Tricolpites	*aspermarginis*																						
	Tricolpites	sp A							5	1.18	25	6.14					64	8.23					10	2.21
	Tricolpites	*cooksonae*			1	0.23	1	0.23					8	2.00			2	0.26	3	0.74			4	0.88
	Tricolpites	*delicatulus*	1	0.21									15	3.75			5	0.64						
	Tricolpites	*giganteus*																						
	Tricolpites	*gillii*																	1	0.25			4	0.88
	Tricolpites	*reticulatus*	78	16.63	57	13.23	72	16.55	50	11.85	22	5.41			120	32.35	103	13.24	64	15.69	7	1.70	67	14.82
	Tricolpopollenites	sp	3	0.64			8	1.84	10	2.37	25	6.14			45	12.13	50	6.43					47	10.40
	Tricolpate	A																					1	0.22
	Tricolpate	B																						
Pollen Stephanocolpate																								
	Ephedripites	sp							1	0.24														
	Glencopollis	*ornatus*																						
	Stephanocolpate	A																						
	Stephanocolpate pollen	B																						
	Other stephanocolpate pollen										1	0.25												
Pollen Tricolporate																								
	Gemmatricolporites	*berbicensis*																						
	Malvacipolloides	sp							1	0.24														
	Tricolporate pollen	B			1	0.23																		
	Tricolpites	sp B																					2	0.44
	Rhoipites	A	1	0.21																	1	0.24		
	Rhoipites	B			2	0.46					3	0.74												
	Rhoipites	C	4	0.85									1	0.25			1	0.13	8	1.96				
	Rhoipites	D	1	0.21							1	0.25												
	Rhoipites	E	3	0.64									5	1.25					1	0.25	9	2.19	5	1.11
	Rhoipites	F	12	2.56	5	1.16			15	3.55	11	2.70			26	7.01					34	8.27	3	0.66
	Rhoipites	G	78	16.63	47	10.90	70	16.09	50	11.85			71	17.75							7	1.70	14	3.10
	Rhoipites	H	2	0.43			1	0.23			1	0.25							4	0.98	23	5.60		
	Rhoipites	J			1	0.23																		
	Rhoipites	K	4	0.85	1	0.23	1	0.23			6	1.47							2	0.49	3	0.73		
	Rhoipites	L			6	1.39					1	0.25					6	0.77	6	1.47				
	Rhoipites	sp	51	10.87	66	15.31	148	34.02	140	33.18	223	54.79	84	21.00			·7	0.90	107	26.23	62	15.09	83	18.36
	Simpsonipollis	sp A	10	2.13	12	2.78					1	0.25	2	0.50	1	0.27								
	Simpsonipollis	sp	68	14.50	4	0.93	4	0.92	5	1.18	2	0.49	16	4.00					1	0.25				
	Tricolporites	sp			45	10.44	14	3.22	5	1.18	2	0.49	88	22.00			5	0.64	15	3.68			10	2.21
	Tubulifloridites	*antipodica*							3	0.71													15	3.32
	Tubulifloridites	*viteauensis*																					1	0.22
	Tubulifloridites	sp A																						
	Tubulifloridites	sp																			1	0.24	3	0.66
	Verrutricolporites	sp							1	0.24														
	Tricolporate pollen	A																	2	0.49	1	0.24	5	1.11
Pollen Stephanocolporate																								
	Retistephanocolpites	sp					1	0.23	4	0.95			3	0.75										
	Sapotaceoidaepollenites	sp	4	0.85	8	1.86	2	0.46	9	2.13			20	5.00							2	0.49		
	Stephanocolporites	sp			4	0.93									1	0.27			5	1.23	5	1.22		
	Stephanocolporate	A																						
	Stephanocolporate	B																						
	Stephanocolporate	C																						
Pollen Syncolporate																								
	Cupanieidites	*major*	4	0.85	23	5.34	6	1.38	4	0.95			13	3.25			1	0.13	1	0.25	4	0.97		
	Cupanieidites	*orthoteichus*	2	0.43			13	2.99	6	1.42			4	1.00					1	0.25				
	Cupanieidites	sp							6	1.42							1	0.13	1	0.25			4	0.88
	Triorites	*edwardsii*																						
	Myrtaceidites	*oceanicus*	1	0.21																				
	Myrtaceidites	*parvus*																			2	0.49	4	0.88
	Porosipollis	sp															1	0.13						
	Retisyncolporites	sp	20	4.26									3	0.75					2	0.49				
Pollen Inaperturate																								
	Araucariacites	sp	1	0.21	1	0.23			7	1.66	10	2.46			3	0.81	7	0.90						
	Inaperturate pollen	A											1	0.25										
Pollen Tetrads/Polyads																								
	Acaciapollenites	sp			2	0.46																		
	Dicotetradites	sp																						
	Ericipites	sp																	7	1.72	10	2.43	1	0.22
Incertae sedis																								
	Incertae sedis A		7	1.49	7	1.62					10	2.46	6	1.50	7	1.89	12	1.54	48	11.76	3	0.73		
	Incertae sedis B																							
Specimens counted			469	100.00	431	100.00	435	100.00	422	100.00	407	100.00	400	100.00	371	100.00	778	100.00	408	100.00	411	100.00	452	100.00

	Clavatipollenites	sp	17			12	
	Striamonocolpites	sp	23			18	
Pollen Trichotomocolpate							3
	Trichotomocolpate	A	4			3	
Pollen Tricolpate				2520			252
	Cupuliferoidaepollenites	sp	149			8	
	Echitricolpites	sp	1			1	
	Gemmatricolpites	sp	5			5	
	Retibrevitricolpites		8			8	
	Striatopollis	sp	51			13	
	Tricolpites	*alveolatus*	20			13	
	Tricolpites	*aspermarginis*	19			9	
	Tricolpites	sp A	120			24	
	Tricolpites	*cooksonae*	38			23	
	Tricolpites	*delicatulus*	31			8	
	Tricolpites	*giganteus*	7			3	
	Tricolpites	*gillii*	127			21	
	Tricolpites	*reticulatus*	1499			76	
	Tricolpopollenites	sp	442			37	
	Tricolpate	A	2			2	
	Tricolpate	B	1			1	
Pollen Stephanocolpate				17			14
	Ephedripites	sp	1			1	
	Glencopollis	*ornatus*	8			8	
	Stephanocolpate	A	1			1	
	Stephanocolpate pollen	B	6			4	
	Other stephanocolpate pollen		2			0	
Pollen Tricolporate				3973	4343		543
	Gemmatricolporites	*berbicensis*	15			5	
	Malvacipolloides	sp	2			2	
	Tricolporate pollen	B	7			8	
	Tricolpites	sp B	7			7	
	Rhoipites	A	17			17	
	Rhoipites	B	47			25	
	Rhoipites	C	85			17	
	Rhoipites	D	16			4	
	Rhoipites	E	120			32	
	Rhoipites	F	175			29	
	Rhoipites	G	380			10	
	Rhoipites	H	80			16	
	Rhoipites	J	16			13	
	Rhoipites	K	114			17	
	Rhoipites	L	64			11	
	Rhoipites	sp	1925			153	
	Simpsonipollis	sp A	35			17	
	Simpsonipollis	sp	115			24	
	Tricolporites	sp	530			20	
	Tubulifloridites	*antipodica*	55			52	
	Tubulifloridites	*viteauensis*	2			2	
	Tubulifloridites	sp A	1			1	
	Tubulifloridites	sp	15			11	
	Verrutricolporites	sp	2			2	
	Tricolporate pollen	A	148			48	
Pollen Stephanocolporate				139			73
	Retistephanocolpites	sp	17			13	
	Sapotaceoidaepollenites	sp	78			39	
	Stephanocolporites	sp	39			16	
	Stephanocolporate	A	2			2	
	Stephanocolporate	B	2			2	
	Stephanocolporate	C	1			1	
Pollen Syncolporate				231			62
	Cupanieidites	*major*	78			35	
	Cupanieidites	*orthoteichus*	32			12	
	Cupanieidites	sp	71			0	
	Triorites	*edwardsii*	1			1	
	Myrtaceidites	*oceanicus*	2			2	
	Myrtaceidites	*parvus*	9			5	
	Porosipollis	sp	1			1	
	Retisyncolporites	sp	37			6	
Pollen Inaperturate				92	92		22
	Araucariacites	sp	88			20	
	Inaperturate pollen	sp A	4			2	
Pollen Tetrads/Polyads				21	303		8
	Acaciapollenites	sp	2			2	
	Dicotetradites	sp	1			1	
	Ericipites	sp	18			5	
Incertae cedis				282			31
	Incertae sedis A		280			30	
	Incertae sedis B		2			1	
Specimens counted				11332	11332		1788



Discussion

Chapter 4

Discussion

4.1 Introduction

The body of this research consisted of systematic, descriptive palynology. Assemblages produced for each peat horizon determined a likely age bracket for the sediments, which is compared to established stratigraphic events. Evidence for the presence of the rainforest covering the southern continents during the early Tertiary is examined. The observed variations within the palynofloras are reviewed in the context of the overall environment.

4.2 Physical setting

The physical situation of the west coast and the palaeochannels was likely to have been similar to that of today. The mountains to the east are composed of ancient gneisses and would have existed then as now, except for topographical adjustments due to weathering. The mountains would probably have been the source of the headwaters of the rivers responsible for the palaeochannels. As several channels exist parallel to each other and perpendicular to the coast, with the mountain highlands close by, the rivers were relatively short in length.

The sedimentary environment may have been similar to the situation described by Plint (1984). As sea level is known to have been constantly changing throughout this time it is possible that a barrier island developed offshore, enclosing a sheltered inshore region of lagoons accumulating fine-grained sediments. At times, when sea level was lower, the rivers were solely responsible for sedimentation in shallow flood-plain lakes. Occasionally, when sea level rose, marine incursions disrupted the sequence.

4.3 Geochronology

4.3.1 Age brackets

The stratigraphic position indicated by the palynomorphs lies between the Palaeocene and the Eocene. The age of every palynoflora fitted well within this bracket and as they are broadly similar in age, the three palaeochannels were presumably operating at the same time.

4.3.2 Zonations

The west coast sediments did not fit into any established zones. No new ones were proposed in this thesis.

Southern Africa has been geographically isolated for approximately 100 My from the other remnants of the Gondwanan supercontinent. Although floristically it belongs to the Southern Gondwana Province, it does not share one of the province's most important elements, *Nothofagidites*, from *Nothofagus*, the southern beech. Many of the zonations erected elsewhere rely on this palynomorph. McLachlan & Pieterse (1978), Coetzee (1978) and Scholtz (1985) were not able to

relate their findings to either the tropical zones erected by Germeraad, Hopping & Muller (1968) or the Australian/New Zealand zonations as the characteristic pollen types were not found. Provincialism, latitudinal zonation, diachronous ranges and problems of taxonomic differentiation add to the difficulty of making long-distance correlations (Batten 1996) and this held true for the current research.

The results from the west coast sites were only briefly compared to the southern African zones of Coetzee (1978) and Coetzee & Rogers (1982) as those zones were dated as Miocene and the west coast assemblages appeared to be Palaeo-Eocene.

4.4 Palaeoflora

The palaeoflora comprised ferns, gymnosperms and angiosperms, ranging from trees and shrubs to herbs and vines (Table 3.2).

The regional scenario, taking into account the physical setting, the established vegetation and the palynofloras found, would probably have been one with an open forest occupying a flat coastal plain. The forest with its scattered trees, vines and shrubs and an herbaceous groundcover is the type of vegetation likely to have produced the palynofloras found.

The west coast sites are therefore of some importance and add new information essential to the better understanding of the geological history of the area.

4.4.1 Evidence for a forested landscape

Axelrod & Raven (1978) suggested that southern Africa was covered with lowland subtropical or temperate rainforest during the Palaeogene.

The west coast palynofloras contained saccate pollen from podocarps, which are forest trees. Araucarian pollen, also from forest trees, was present although relatively uncommon, and this may imply that this type of tree was rarer or further away. Trilete spores were found, attributable to tree ferns (Cyatheaceae). Most of the angiosperm families mentioned include trees.

Badly preserved pieces of fossil wood were found in the field.

The vegetation of the west coast at the time when the palaeochannels were active was therefore probably forested.

4.4.2 Comparison with Arnot

Scholtz (1985) concluded that the vegetation at Arnot, close to the west coast sites in space and possibly also in time, was probably an open-canopied dry subtropical forest with understorey layers. Virtually all of the plant families found at Arnot are represented in the west coast palynofloras, implying that the vegetation was superficially similar. In detail, some significant differences may be seen, as Scholtz (1985) considered that a vegetation gradient between the xeric northwestern interior and the more humid coastal regions already existed in the late Cretaceous. The main differences may well be attributed to the environment in which the sediments accumulated, rather than the age of the deposit. The Arnot sediments infilled an inland crater lake while the sediments in the current study were coastal and thus subject to different environmental conditions.

4.4.3 Evidence for variations in the palaeoflora

The samples were taken to investigate changes to the palaeoflora both through time and space, and they produced several different patterns as noted above. However, no distinct trends were revealed. Instead, the patterns essentially reflect that the flora of the region was not uniform. This conclusion is in accordance with variations in the sedimentary environment.

Pattern 1 was the most commonly seen and is taken to represent the regional vegetation; the open forest with shrubs and understorey layers. In the river valley itself, when the river had changed its course, ferns would have been among the first plants to colonise the abandoned channel, producing peat with the type of assemblage seen in Pattern 2. Close to the riverbanks, the gallery forest having more trees would have produced Pattern 3.

One or two minor features were indicated by the distribution patterns. More research is needed to confirm their significance or otherwise.

Lack of gymnosperm pollen in the channel peats. Podocarp and araucarian pollen was rarer in the lower horizon at Koingnaas. Further investigation will determine whether the increase in this pollen in the higher levels is significant.

Change in spore content. More trilete than monolete spores were found in the Koingnaas channel peats but the reverse was true for the sediments above the main peat horizon. The latter trend was matched at Langklip.

Change in assemblages at Langklip. The stratigraphic sequence taken at the base of the peat at Langklip produced a similar pattern for every sample, while the samples taken higher up varied in the same way as seen at Koingnaas. The reason for this could be merely localised, not due to changes in the regional environment or in the climate.

Increase in the monocolpates and saccates in the Somnaas/Noup samples. These two groups were better represented in the Somnaas/Noup samples than elsewhere. As they represent palms and podocarps, two distinct plant groups, a climatic change may be indicated.

4.4.4 Important plant families represented

Hardly any of the plant families suggested by the west coast palynofloras exist in the area today. The modern vegetation consisting mainly of Mesembryanthemaceae and other dry-adapted forms is greatly in contrast with the fossil scenario.

Some of the plant families identified occur in other parts of southern Africa today, such as the Proteaceae and the Compositae. Others, such as the Podocarpaceae, are found in the relict forest at Knysna.

Proteaceae. The proteas are a large and prominent component of today's Cape fynbos vegetation. The family has a fossil record that starts in the tropics, although it is predominantly temperate today (Romero 1993). The west coast *Proteacidites* sp possessed a narrow spectrum of morphological features. Their lack of diversity is in itself significant, because in palynofloras of this age from Australia and New Zealand, large reticulate and granulate types characterise the assemblages (Kemp 1975).

Podocarpaceae. Forests rich in podocarps covered southern Africa in the early Cretaceous (Coetzee 1993). Today they are only found in relict forests such as at Knysna. Their presence in the west coast palynofloras provides the key element in the reconstruction of the vegetation.

Compositae. The presence of Compositae pollen was one of the most important contributions of this project. Occurrences of Compositae pollen are rare before the Miocene, and as the west coast sediments appear to be Palaeo-Eocene, this implies that

these sediments provide one of the earliest known records of this important plant family. Compositae have been recorded from South America in the Eocene (Romerro 1993), Ninetyeast Ridge in sediments older than Oligocene (Kemp & Harris 1977) and Argentina in sediments tentatively dated as late Oligocene, and possibly Eocene (Barreda 1993). This early occurrence of Compositae questions Coetzee's southern Cape pollen zones from Noordehoek and Langebaan which were largely based on the long-established assumption that the first appearance of Compositae was in the late Oligocene (as summarised by Traverse 1988). The widespread distribution mentioned above consisted of rare grains of similar type, in sediments appearing to be 'too old' for Compositae. It is puzzling, as it has been established that continental breakup and the development of the oceanic basins mostly prohibited the migration of taxa to and from southern Africa for the last 100 My (early Late Cretaceous). The pollen is not of a type which is likely to be anemophilous, and the ocean basins were likely to have been too wide to facilitate this. The most logical explanation is that the Compositae is a more ancient group than previously thought.

Palmae. Several monocolpate pollen types were associated with the Palmae. Coetzee (1978) surmised that the presence of Palmae indicated subtropical to tropical conditions, and the alternation of Palm-rich horizons at Noordehoek with others containing conifer pollen led to the conclusion that the climate had fluctuated. In the current research, similar variations were seen. However, these sediments are likely to have been deposited as part of a discrete unit, with little possibility of climate change within the unit. Palmae may occur today in other than tropical conditions (Traverse 1988) and, as has already been stated, the Palaeogene is the earliest time period for which reliable affinities may be quoted, the climatic tolerance may not be absolutely valid. A palaeotropical maximum is thought to have occurred in the late Palaeocene /

early Eocene (Frakes 1979), and the palm pollen found in the west coast sediments could have been produced by the more hardy palm types before conditions deteriorated too much for them to survive.

4.4.5 Summary of the palaeoflora

The palaeoflora had more elements in common with the established late Cretaceous floras than with the modern vegetation. Palynomorphs such as *Araucariacites*, *Cicatricososporites*, *Arecipites*, and *Tricolpites* spp. are common in the late Cretaceous (Scholtz 1985). Palynomorphs such as the Compositae (*Tubulifloridites*) and the reticulate tricolporates (*Rhoipites*) are better known from the Tertiary. Forms which characterise the dry-adapted modern flora such as *Ericipites* are rare.

4.5 Palaeoclimate

As the physical situation has altered little since the palaeochannels were active, and the vegetation has changed extensively, the most likely cause of the change is climatic.

During the time that the palaeochannels were active, the west coast is concluded to have experienced humid and warm (sub-tropical to temperate) conditions with no hint of impoverishment.

Such a conclusion agrees well with the proposed Palaeocene-Eocene age bracket, as it has been established that southern Africa experienced a humid and warm climate

during the late Cretaceous and early Tertiary. The development of the Antarctic ice sheet began to produce cooling effects in the Oligocene and has been linked to aridity in the Miocene, but as no sign of the drop in temperature was implied in the palynofloras examined, the conclusion is that they date from before this time.

Summary and Conclusions

A total of 69 peat samples were taken from three sites in Namaqualand where palaeochannels thought to be of Pliocene age were found. A total of 30 proved positive for palynomorphs. At Koingnaas, the main peat horizon was sampled, as well as peat stringers above it and peats found in channel scours at a lower stratigraphic level. Each level was considered separately. At Langklip, the peat horizon occurred at the base of the palaeochannel. The peats from Somnaas/Noup were known from borehole data only. Standard maceration techniques were performed in the laboratory to prepare the material. Light and scanning electron microscopy were used to record the palynomorphs encountered.

Microphotographs were taken of representative specimens and these were compared with published illustrations to effect identifications. The literature database concentrated on southern hemisphere palynology. Several new forms were discovered, to be described later.

A separate palynological assemblage was constructed for each peat horizon investigated. Porate, colpate and colporate pollen grains produced by angiosperms dominated the assemblages. Saccate and inaperturate pollen representing gymnosperms were found to constitute a small percentage. Trilete and monolete spores mostly representing ferns made a significant contribution.

The reconstruction of the palaeoflora was based on the palynomorphs' known botanical affinities. The physical situation dictated that the environment was coastal, with lagoons produced by short rivers. A measure of altitude zonation was provided by the nearby mountains of the Escarpment. Three basic types of assemblage were found, and

these were linked to physical changes in the local environment. Most of the samples represented the peat accumulating in the environs of a river, where shrubland with trees and herbaceous plants existed. Some of the samples were taken from peats formed on the riverbanks where the vegetation consisted of gallery forest. Other samples, dominated by ferns, may represent the colonization of abandoned river courses.

The palaeoclimate was estimated using the climatic tolerances of modern plants with affinities to the palynomorphs found, suggesting conditions were humid and subtropical.

The established age ranges of the palynomorphs indicated that the age of the sediments was Palaeocene-Eocene, confirming that they are significantly older than previously estimated. As there was no discernable difference in the age brackets of each palynoflora considered, the peats are concluded to have been formed contemporaneously. The sediments are most likely to be mid-late Eocene in age, as a regression of the sea began in the late Maastrichtian and continued until the late Palaeocene. During this regression, the river systems would have been rejuvenated and more likely to remove material than deposit it. Palaeocene rocks have not been found onshore. Final confirmation of the mid-late Eocene date is provided by the palynomorphs themselves. Such a wide spectrum of tricolporate angiosperm pollen is to be expected at this time at the earliest. The Compositae in particular cannot be dated any earlier, according to current palaeobotanical theories. The complete palaeoflora indicated concurs with the accepted distribution of forest in the southern continents at this time. Climatic conditions were still warm and humid, dating the sediments before the advance of polar ice in Oligocene times.

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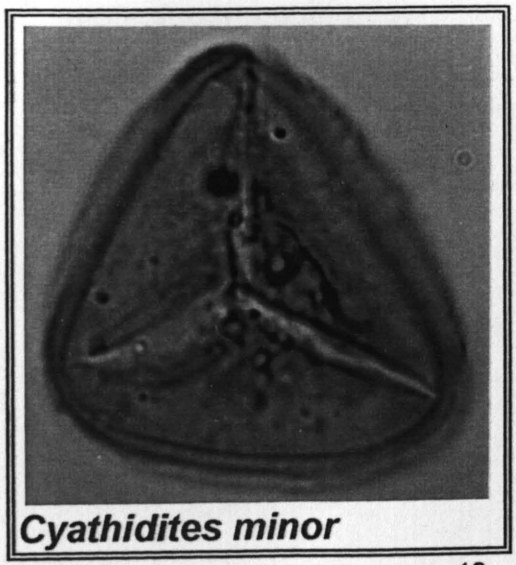
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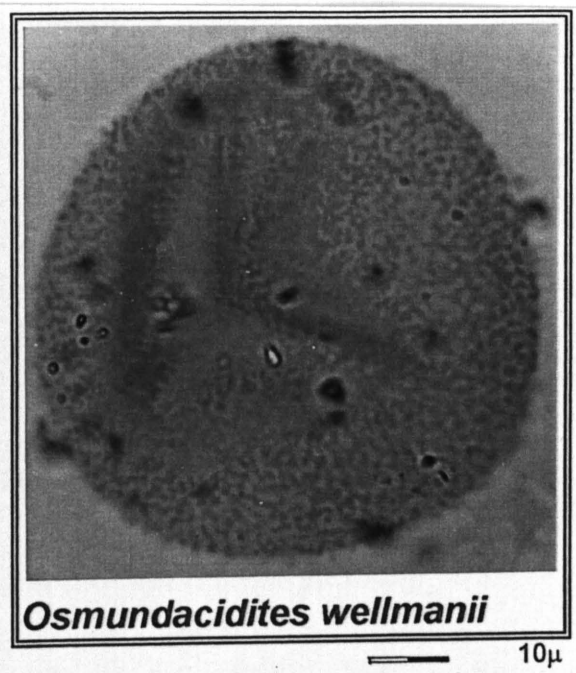
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Colour Plates



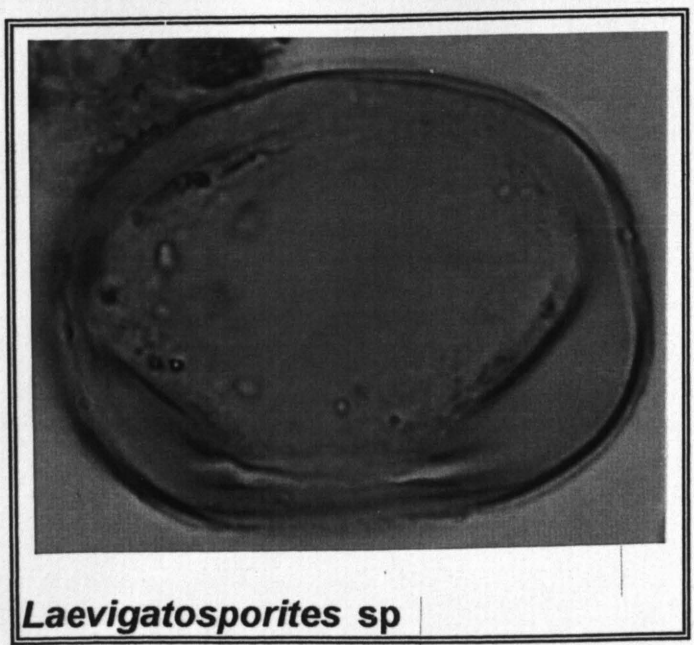
Cyathidites minor

10μ



Osmundacidites wellmanii

10μ



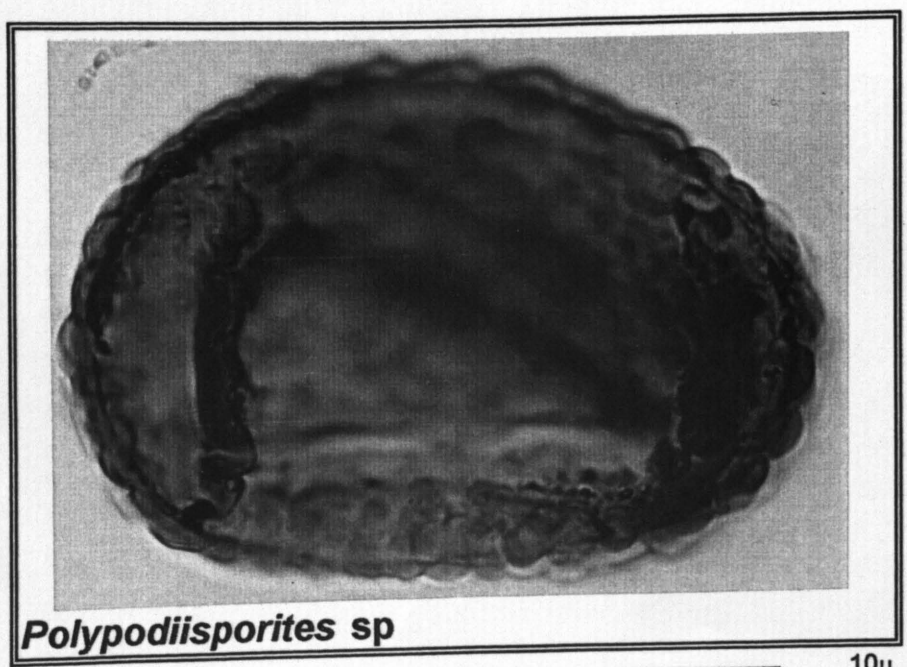
Laevigatosporites sp

10μ



Rhoipites sp A

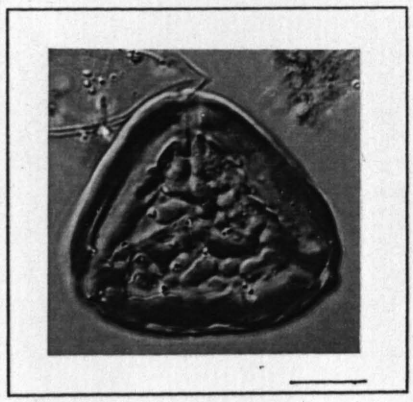
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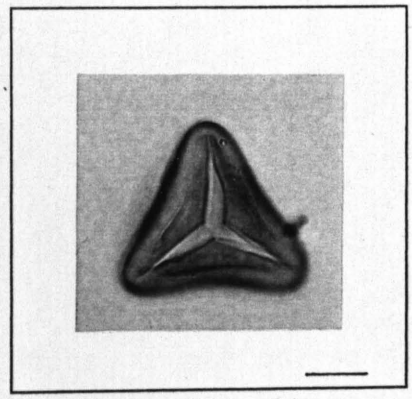
Polypodiisporites sp

10μ

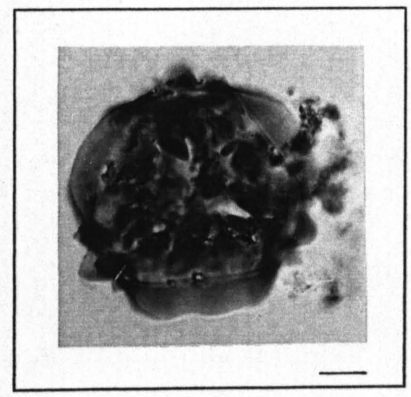
Colour Plate 1



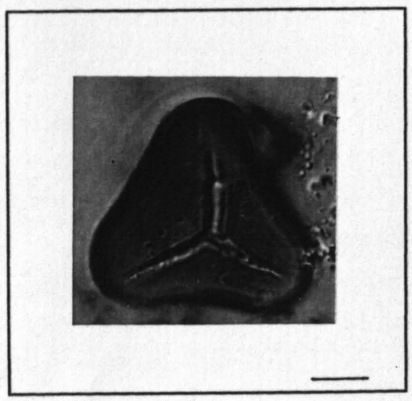
Polypodiaceoisporites retirugatus



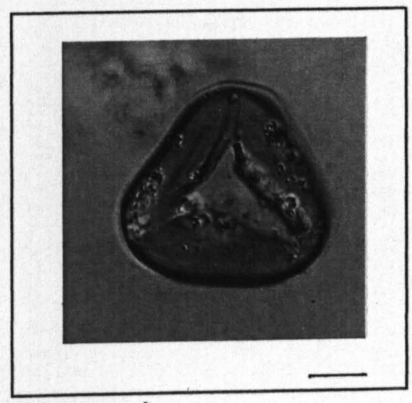
Polypodiaceoisporites tumulatus



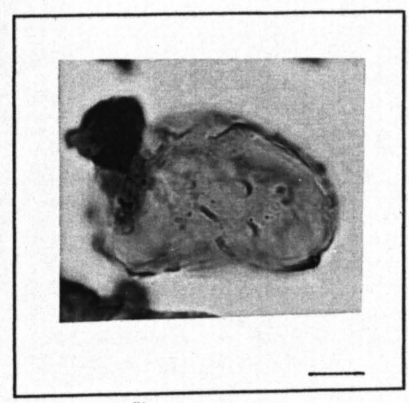
Verrucingulatisporites sp



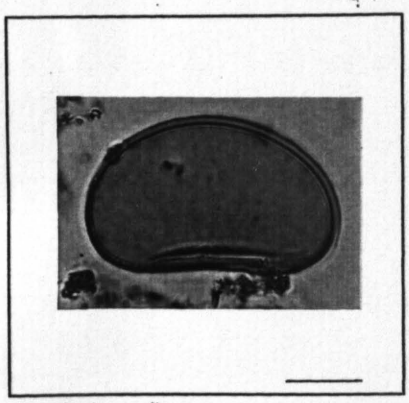
Cyathidites australis



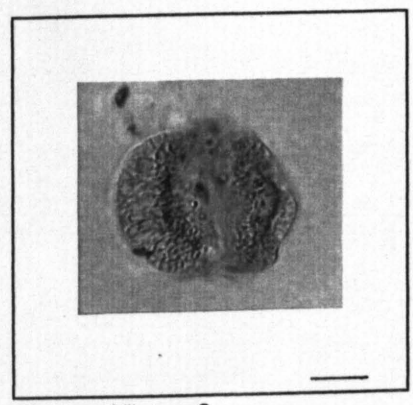
Trilete spore A



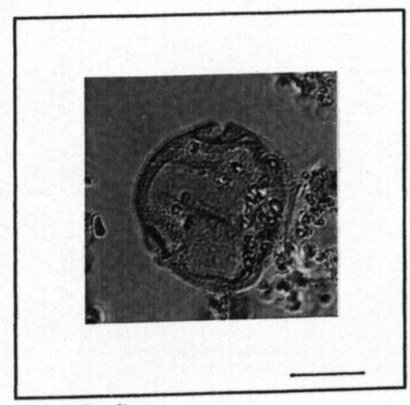
Perinomonolites sp



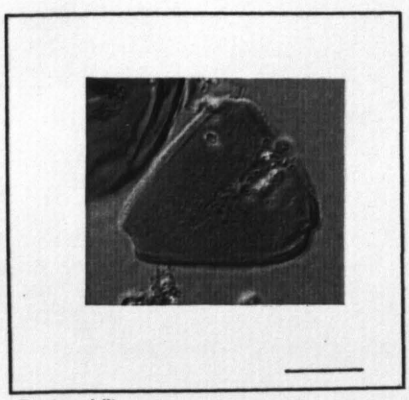
Laevigatosporites sp



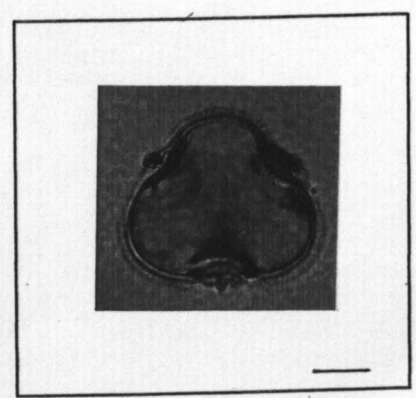
Podocarpidites sp C



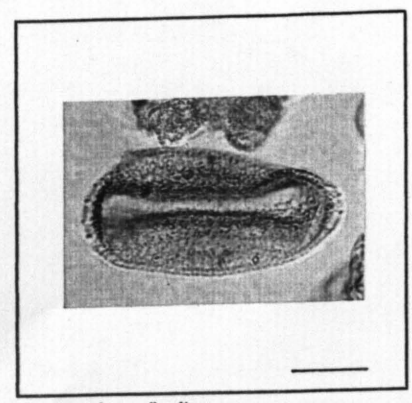
Cricotriporites sp



Proteacidites sp



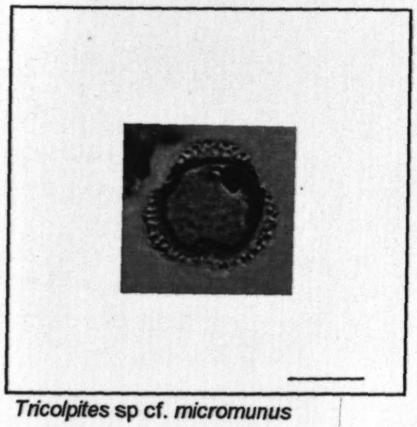
Intratriporopollenites sp



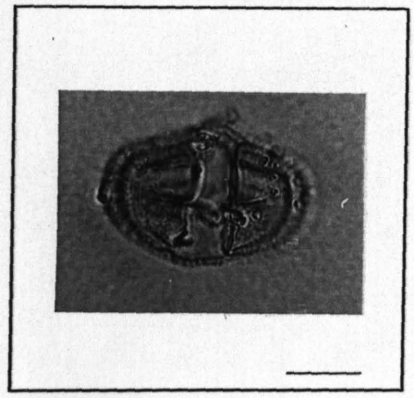
Monocolpopollenites sp

Colour plate 2

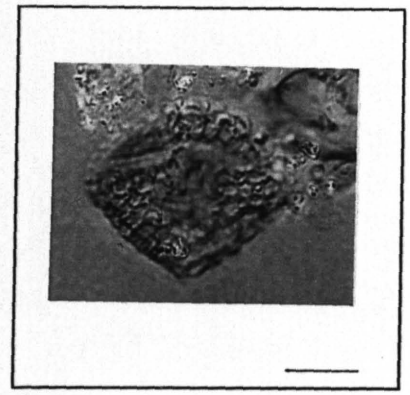
Scale bars = 10μ



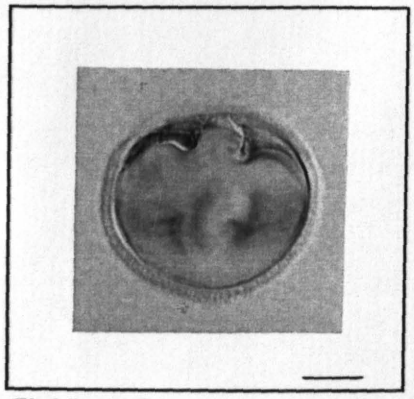
Tricolpites sp cf. *micromunus*



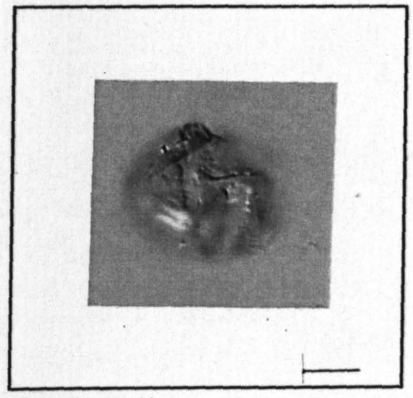
Rhoipites sp B



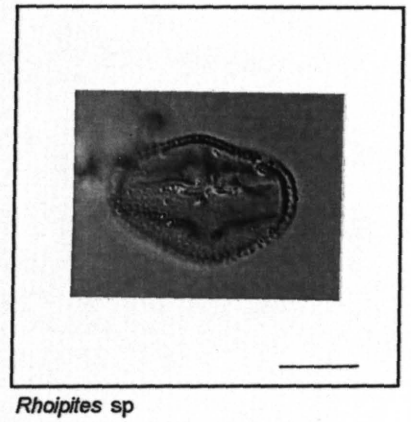
Rhoipites sp D



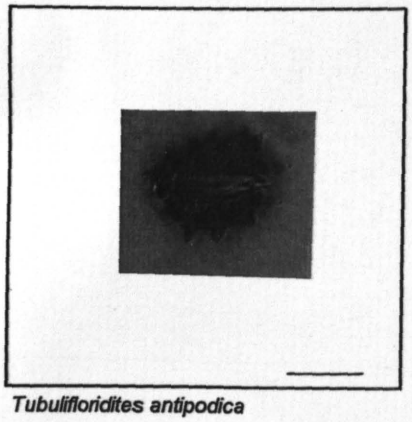
Rhoipites sp E



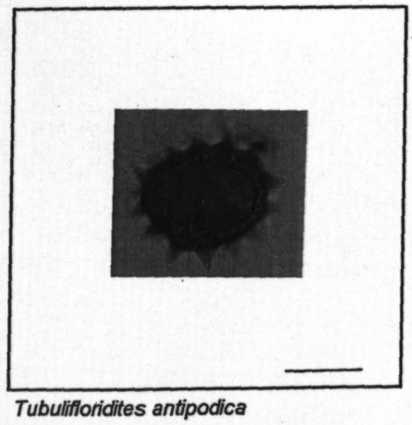
Rhoipites sp H



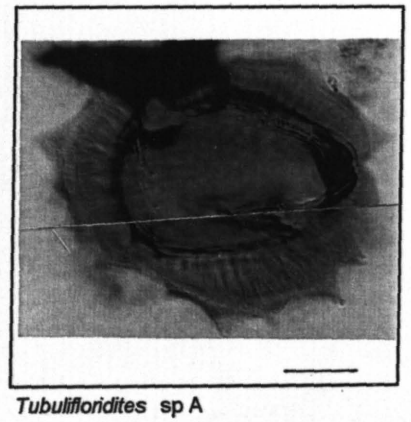
Rhoipites sp



Tubulifloridites antipodica



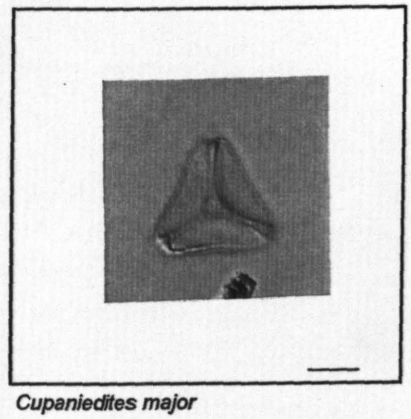
Tubulifloridites antipodica



Tubulifloridites sp A



Sapotaceoidaepollenites sp



Cupaniedites major

Colour plate 3

Scale bars = 10 μ