

CHAPTER-V

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5.0 PALYNOMORPHS AND BIOZONATION :

The subsurface sediments represented by Olpad, Cambay, Ankleshwar and Dadhar formations contain fair to rich microfloral assemblage which are represented by plant groups pteridophytes, gymnosperms, angiosperms and phytoplanktons. Two hundred ninety three species belonging to one hundred forty four genera of index/zonal significance ranging in age from Paleocene to Oligocene have been identified and systematically described by the author. Some of these have a wide range of distribution, while others have restricted to a small stratigraphic interval both in space and time.

5.1 Distribution of Palynomorphs :

The vertical distribution of palynomorphs including dinoflagellate cysts from Olpad Formation, Cambay Formation, Ankleshwar Formation and Dadhar Formation are plotted in charts 1.1A, 1.1B, 1.1C, 1.1D, 1.1E, 1.1F, 1.2A, 1.2B, 1.3, 1.4A, 1.4B, 1.5 and 1.7. The wells Gandhar-B,C,D Pakhajan-A and Dahej-A taken up for thesis study are terminated in Cambay Formation except wells Gandhar-A, Palej-A and Matar-A. These wells were terminated in Olpad Formation.

The preservation of both pteridophytic spores and angiospermous pollens are very good in Cambay and Ankleshwar formations. In the Dadhar Formation, preservation is moderate to good. The phytoplanktons also fair to moderately distributed in these formations.

ANKLESHWAR				DADHAR				FORMATION		BIOSTRATIGRAPHY OF WELL GANDHARA-A							
HAZAD		KANWA	ARDOL	TELWA				MEMBER		LITHOLOGY		DEPTH IN METRES		CUTT/SWC/CON CORE			
												2205 2215 2225 2235 2245 2255 2265 2275 2285 2295 2305 2315 2325 2335 2345 2355 2400 2425 2445 2470 2490 2515 2535 2555 2575 2595 2615 2630 2650 2665 2675 2690 2710 2735 2750 2765 2805 2815 2825 2845 2865 2885		11-25 6-10 2-5 26-50 27-50		CYATHIDITES MINOR CYATHIDITES SP CYATHIDITES AUSTRALIS LYGODIUMSPORITES SP MAGNASTRIATITES SP MAGNASTRIATITES HOWARDII LYCOPODIUMSPORITES SP DANDOTIASPORA SP POLYPODIACEOISPORITES GRACILLIMUS POLYPODIACEOISPORITES SP TRILETES SPP VERUTRILETES SP SCABRATRILETES SP DELTOIDOSPORA SP CICATRICOISPORITES SP CICATRICOISPORITES VENUSTUS OSMUNDACIDITES SP LAEVIGATOSPORITES SPP LAEVIGATOSPORITES OVATUS LAEVIGATOSPORITES SP. C.I.L. GRACILLIMUS MONOLETES SP MONOLETES MAJOR SCABRAMONOLETES SP POLYPODIISPORITES SP POLYPODIISPORITES FORMOSUS POLYPODIISPORITES MINOR POLYPODIACEAESPORITES SP PEDIASTRUM SP FUNGAL SPORE DICELLAESPORITES SP MULTICELLAESPORITES SP MICROTHALLITES SP FUSIFORMISPORITES SP CIRCULISPORITES SP PODOCARPIDITES SP PODOCARPIDITES CLASSICUS MONOCOLPOPOLLINITES SP TRICOLPITES FISSILIS TRICOLPITES DENSIORNATUS TRICOLPITES MICRORETICULATUS TRICOLPITES MINOR TRICOLPITES SP FAVI TRICOLPITES MAGNUS TRICOLPITES MARGOCOLPITES SP TRICOLPITES RETICULATUS ECHIZONOCOLPATUS SP STEPHANOCOLPITES SP RETISTEPHANOCOLPITES SP POLYBREVICOLPITES NEYVELII POLYCOLPITES SP POLYCOLPITES FLAVATUS POLYCOLPITES PEDALIACEOIDES POLYCOLPITES GRANULATUS GRAMINIDITES ANNULATUS SPINAIPERTURITES SP PLUMBAGINACIPITES NEYVELII TRICOLPORITES SP TRIPOROPOLLINITES SP UMBELLIFEROIPOLLINITES OVATUS FOVEOTRICOLPORITES SP RETITRICOLPITES SP STRIATOPOLLIS BELLUS STRIACOLPORITES SP STRIACOLPORITES OVATUS BOMBACACIDITES TRILOBATUS RHOIPITES SP RHOIPITES CONATUS RETIPOLLINITES CONFUSUS PSILATRICOLPORITES OPERCULATUS CAPRIFOLIIPITES OBSCURUS	
PROXAPERTITES CURSUS-POLYCOLPITES FLAVATUS ZONE				PALMAEPOLLINITES KUTCHENSIS -MARGOCOLPORITES TSUKADAI ZONE				MAGNASTRIATITES HOWARDII-COUPERIPOLLIS RARISPINOSUS ZONE				ZONATION		EXAMINED BY		CHART - I-1/A	
MIDDLE EOCENE				UPPER EOCENE				OLIGOCENE				AGE					

A N K L E S H W A R				D A D H A R				FORMATION	☒ 1-25 ☒ 6-10 ☒ 2-5 ☒ SOLITARY ☒ 26-50 ☒ > 50				BIOSTRATIGRAPHY OF WELL GANDHAR-A
HAZAD	KANWA	ARDOL	TELWA					MEMBER					
								LITHOLOGY					
								DEPTH IN METRES.					
2085	2065	2045	2025	2005	1985	1965	1945	2205	CUTT/SWC/CON CORE				
									POLYBREVICOLPORITES CEPHALUS				
									PISTILLIPOLLENITES SP				
									ARALIAEOPOLLENITES SP				
									MELIAPOLLIS SP				
									CUPANIIDITES FLACCIDIFORMIS				
									PSEUDONOTHOFAGIDITES KUTCHENSIS				
									DICOLPOLLIS SP				
									DICOLPOLLIS KALEWENSIS				
									PALMAEPOLLENITES SP				
									PALMAEPOLLENITES KUTCHENSIS				
									PALMAEPOLLENITES NADHAMUNII				
									PALMAEPOLLENITES OVATUS				
									PALMIDITES SP				
									PALMAEPOLLENITES EOCENICUS				
									PROXAPERTITES SP				
									PROXAPERTITES OPERCULATUS				
									PROXAPERTITES CURSUS				
									LONGAPERTITES SP				
									ARECIPITES INDICUS				
									ARECIPITES PUNCTATUS				
									LILIACIDITES SP				
									COUPERIPOLLIS SP				
									COUPERIPOLLIS CYMBATUS				
									COUPERIPOLLIS BREVISPINOSUS				
									COUPERIPOLLIS KUTCHENSIS				
									COUPERIPOLLIS RARISPINOSUS				
									ZONOCOSTITES RAMONAE				
									MARGOCOLPORITES SP				
									MARGOCOLPORITES TSUKADAI				
									MARGOCOLPORITES SAHANI				
									MARGINIPOLLIS SP				
									MARGINIPOLLIS KUTCHENSIS				
									MARGINIPOLLIS CONCINNUS				
									JUGOPOLLIS TETRAPORITES				
									PSILODIPORITES SP				
									PSILODIPORITES HAMMENI				
									THORITES TUBIFERUS				
									MYRICALEOIPOLLENITES SP				
									MYRICALEOIPOLLENITES DUBIUS				
									PELLICIEROIPOLLIS LANGENHEIMI				
									PROTEACIDITES RETUSUS				
									ANACOLSIDITES TRILOBATUS				
									CORDOSPHAERIDIUM SP				
									HYSTRICHOSPHAERIDIUM TUBIFERUM				
									HYSTRICHOSPHAERIDIUM SP				
									AREOSPHAERIDIUM CORNUITUM				
									GLAPHYROCISTA SP				
									AREOSPHAERIDIUM SP				
									SPINIFERITES SP				
									SPINIFERITES RAMOSUS VAR MULTIREVIS				
									HOMOTRYBLIUM SP				
									POLYSPHAERIDIUM SP				
									POLYSPHAERIDIUM SUBTILE				
									CLEISTOSPHAERIDIUM SP				
									CLEISTOSPHAERIDIUM DIVERSISPINOSUM				
									DINOFLAGELLATE CYSTS				
									OPERCULODINIUM SP				
									GONYAULACYSTA SP				
									MICHRYSTRIDIUM SP				
									CYCLOPSIELLA SP CF C. VIETA				
									COLLUMOSPHAERA FRUTICOSA				
PROXAPERTITES CURSUS-POLYCOLPITES FLAVATUS ZONE								PALMAEPOLLENITES KUTCHENSIS - MARGOCOLPORITES TSUKADAI ZONE				MAGNASTRIATITES HOWARDII-COUPERIPOLLIS RARISPINOSUS ZONE	
MIDDLE EOCENE		UPPER EOCENE		Oligocene				ZONATION	AGE		EXAMINED BY	CHART-1.1/B	

C A M B A Y						FORMATION	☒ 11-25	☒ 6-10	☒ 2-5	☒ SOLITARY	BIOSTRATIGRAPHIC ZONE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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											STEPHANOCOLPITES SP						
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											POLYCOLPITES SP						
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											POLYCOLPITES PEDALICEOIDES						
											POLYCOLPITES GRANULATUS						
											GRAMINIDITES ANNULATUS						
											SPINAINAPERTURITES SP						
											FUMBAGINACIPITES NEYVELII						
											TRICOLPORITES SP						
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											STRIACOLPORITES SP						
											STRIACOLPORITES OVATUS						
											BOMBACACIDITES TRILOBATUS						
											RHOIPITES SP						
											RHOIPITES CONATUS						
											RETIPOLLENITES CONFUSUS						
											PSILATRICOLPORITES OPERCULATUS						
											CAPRIFOLIIPITES OBSCURUS						
MONOCOLPOLLENITES SP-PROXAPERTITES SP ZONE										POLYBREVICOLPORITES CEPHALUS-PELLICEROIPOLLIS LANGENHEIMII ZONE					ZONATION	EXAMINED BY	CHAR.-IIVE
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		HAZAD		MEMBER					
				LITHOLOGY					
				DEPTH IN METRES					
						CUT/ SWC/ CON CORE			
						CYATHOIDITES MINOR			
						CYATHOIDITES SP			
						POLYPODIAEISPORITES SPECIOSUS			
						LYCOPOLIUMSPORITES SP			
						DANDOTIASPORA DILATA			
						POLYPODIAEISPORITES GRACILIMUS			
						LAEVIGATOSPORITES SP			
						LAEVIGATOSPORITES OVATUS			
						POLYPODIISPORITES FORMOSUS			
						POLYPODIISPORITES SP			
						POLYPODIISPORITES MAWMAEENSIS			
						MONOLETES MAJOR			
						POLYPODIISPORITES MINOR			
						PODOCARPIDITES SP			
						PODOCARPIDITES CLASSICUS			
						TRICOLPITES SP			
						TRICOLPITES MINOR			
						TRICOLPITES FISSILIS			
						TRICOLPITES LONGICOLPATUS			
						STEPHANOCOLPITES SP			
						POLYCOLPITES SP			
						POLYCOLPITES FLAVATUS			
						POLYCOLPITES PEDALIAEIOIDES			
						POLYBREVICOLPORITES CEPHALUS			
						POLYGALACIDITES CLARUS			
						POLYBREVICOLPITES NEYVELII			
						TRICOLPORITES SP			
						RHOPITES CONATUS			
						UMBELLIFEROIPLENITES OVATUS			
						STRIACOLPORITES CEPHALUS			
						STRIACOLPORITES OVATUS			
						FAVEOTRICOLPORITES FOVEOLATUS			
						CAPRIFOLIIPITES DESCRETUS			
						SYMPLOCOIPOLLENITES SP			
						RETISTEPHANOCOLPITES WILLIAMS			
						TRIROPOLLENITES SP			
						MELIAPOLLIS RAMANUJAMII			
						TRIOPITES TUBIFERUS			
						MONOCOLPOPOLLENITES SP			
						PALMAEPOLLENITES KUTCHENSIS			
						PALMAEPOLLENITES SP			
						PALMAEPOLLENITES EOCENICUS			
						PALMAEPOLLENITES OVATUS			
						ARECIPITES PUNCTATUS			
						ARECIPITES SP			
						LILIACIDITES SP			
						PROXAPERTITES OPERCULATUS			
						PROXAPERTITES CURSUS			
						DICOLPOPOLLIS SP			
						DICOLPOPOLLIS KALEWENSIS			
						LONGAPERTITES C.F.L. RETIPLATUS			
						COUPERIPOLLIS SP			
						COUPERIPOLLIS KUTCHENSIS			
						COUPERIPOLLIS RARISPINOSUS			
						COUPERIPOLLIS CYMBATUS			
						FLORSCHUETZIA SP			
						ZONOCOSTITES SP			
						PELLEICEROPOLLIS LANGENHEMII			
						PSILODIPORITES HAMMENI			
						MARGINIPOLLIS KUTCHENSIS			
						MARGOCOLPORITES SUKADAI			
						HYSTRICOPOLLENITES DUBIUS			
						HYSTRICOPOLLENITES TETRAPORITES			
						CLEISTOSPHAERIDIUM SP			
						CLEISTOSPHAERIDIUM DIVERSISPINOSUM			
						GLAPHYROCISTA SP			
						GLAPHYROCISTA EXUBERANS			
						POLYSPHAERIDIUM SP			
						POLYSPHAERIDIUM SUBTILE			
						SYSTEMATOPHORA SP			
						TURBIOSPHAERA SP			
						DINOFLAGELLATE CYST TYPE 1			
						HOMOTRYBLIUM FLORIPES			
						CORDOSPHAERIDIUM VIBROSPINOSUM			
						SPINIFERITES SP			
						SPINIFERITES RAMOSA VAR. MULTIBREVIS			
						HYSTRICOSPHAERIDIUM SP			
						HYSTRICHOKOLPOMA GRANULATA			
POLYBREVICOL CEPHALUS-PEL LICIEROIPOLL IS LANGENHEI MII ZONE		PROXAPERTITES CURSUS-POLYCOLPIT- ES FLAVATUS ZONE		MIDDLE EOCENE		LOWER EOCENE		CHART-13	

CAMBAY		ANKLESHWAR			DADHAR		POST DADHAR		FORMATION		1-25 6-10 2-5 26-50 > 50 BIOSTRATIGRAPHY OF WELL PAKHMAN-1A	
		HAZAD	KAN- WA	ARDOL	TELWA					MEMBER		
										LITHOLOGY		
										DEPTH IN METRES		
3840	3840	3840	3840	3840	3840	3840	3840	3840	3840	3840	3840	
3860	3860	3860	3860	3860	3860	3860	3860	3860	3860	3860	3860	
3900	3900	3900	3900	3900	3900	3900	3900	3900	3900	3900	3900	
3920	3920	3920	3920	3920	3920	3920	3920	3920	3920	3920	3920	
3945	3945	3945	3945	3945	3945	3945	3945	3945	3945	3945	3945	
3960	3960	3960	3960	3960	3960	3960	3960	3960	3960	3960	3960	
3980	3980	3980	3980	3980	3980	3980	3980	3980	3980	3980	3980	
4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	
CUTT/SWC/CON CORE												
CYATHIDITES SP												
CYATHIDITES MINOR												
CICATRICOISPORITES SP												
CICATRICOISPORITES VENUSTUS												
MAGNASTRIATITES SP												
MAGNASTRIATITES HOWARDII												
VERRUCATOSPORITES SP												
TRILETES SP												
LYCOPODIUMSPORITES SP												
SCABRATRILETES SP												
LYGODIUMSPORITES SP												
POLYPODIACEOISPORITES SP												
POLYPODIACEOISPORITES SPECIOSUS												
LAEVIGATOSPORITES SP												
LAEVIGATOSPORITES OVATUS												
POLYPODIISPORITES SP												
POLYPODIISPORITES FORMOSUS												
POLYPODIISPORITES MINOR												
MONOLETES SP												
PEDIASTRUM SP												
MICROTHALLITES SP												
FUSIFORMISPORITES SP												
DICELLAESPORITES SP												
CIRCULISPORITES SP												
FUNGAL SPORE												
PODOCARPIDITES SP												
PODOCARPIDITES CLASSICUS												
EPHEDRIPITES SP												
TRICOLPITES SP												
TRICOLPITES MINOR												
STEPHANOCOLPITES SP												
POLYCOLPITES SP												
POLYCOLPITES FLAVATUS												
POLYCOLPITES PEDALACEOIDES												
TRICOLPORITES SP												
RETITRICOLPORITES SP												
ARALIACEOIPOLLENITES SP												
STRIACOLPORITES SP												
STRIACOLPORITES BELLUS												
STRIACOLPORITES CEPHALUS												
POLYBREVICOLPITES NEYVELII												
FOVEOTRICOLPORITES SP												
UMBELLIFEROIPOLLENITES SP												
UMBELLIFEROIPOLLENITES OVATUS												
RHOIPITES SP												
RHOIPITES CONATUS												
PSILATRICOLPORITES SP												
MELIAPOLLIS SP												
RETIIPOLLENITES CONFUSUS												
POLYBREVICOLPORITES CEPHALUS												
MONOCOLPOPOLLENITES BENGALENSIS												
RETIDIPORES SP												
RETIDIPORES BENGALENSIS												
MONOPOROPOLLENITES SP												
PSEUDONOTHOFAGIDITES SP												
TRIPOROPOLLENITES SP												
PALMAEPOLLENITES SP												
PALMAEPOLLENITES KUTCHENSIS												
PALMAEPOLLENITES EOCENICUS												
PALMAEPOLLENITES OVATUS												
PALMAEPOLLENITES NADHAMUNII												
PALMIDITES SP												
COUPERIPOLLIS SP												
COUPERIPOLLIS BREVISPINOSUS												
COUPERIPOLLIS RARISPINOSUS												
DICOLPOPOLLIS SP												
DICOLPOPOLLIS KALEWENSIS												
DICOLPOPOLLIS MICRORETICULATUS												
ARECIPITES INDICUS												
ARECIPITES PUNCTATUS												
POLYBREVICOLPORITES CEPHALUS - PELLICIEROPOLLIS-LANGENHEIMII ZONE		PROXAPERTITES CURSUS-POLYCOLPITES FLAVATUS ZONE		PALMAEPOLLENITES KUTCHENSIS-MARGOCOPORITES TSUKADAI ZONE		MAGNASTRIATITES HOWARDII - COUPERIPOLLIS RARISPINOSUS ZONE		ZONATION		EXAMINED BY		
LOWER EOCENE		MIDDLE EOCENE		UPPER EOCENE		OLIGOCENE		AGE				

C A M B A Y				A N K L E S H W A R				D A D H A R				P O S T D A D H A R				F O R M A T I O N				B I O S T R A T I G R A P H Y O F W E L L P A K H A J A N - A			
				H A Z A D				K A N - W A				A R D O L				T E L W A				M E M B E R			
																				L I T H O L O G Y			
																				D E P T H I N M E T R E S			

ANKLESHWAR		DADHAR	POST DADHAR	FORMATION			STRATIGRAPHY OF WELL DAMEL-A
ARDOL				MEMBER	SOLTARY 26-50 1-25 2-5 6-10 11-25		
				LITHOLOGY			
				DEPTH IN METRES			
					CUTT/SWC/CON CORE		
					LAEVIGATOSPORITES SP LAEVIGATOSPORITES OVATUS SCABRAMONOLETES SP POLYPODIISPORITES SP CYATHIDITES SP CYATHIDITES MINOR SCABRATRIATES SP POLYPODIISPORITES FORMOSUS POLYPODIISPORITES MINOR POLYPODIISPORITES SP MAGNASTRIATITES SP MAGNASTRIATITES HOWARDII CICATRICESPORITES SP MONOLETES SP TRIATES SP LYCOPODIUMSPORITES SP OSMUNDACOIDITES SP LYCOPIUMSPORITES SP MONOLETES MAJOR VERRUCULITES SP POLYPODIACEISPORITES SP DICELLAESPORITES SP MICROTHALITES SP CIRCULISPORITES SP FUSIFORMISPORITES SP TRIPOROPOLLENITES SP TRICOLPORITES SP STRIATOPOLLIS BELLUS POLYGALCIDITES SP STEPHANOCOLPITES SP POLYBREVICOLPITES MEYERII RETRICOLPORITES SP STRIATOPOLLENITES SP TRICOLPITES SP TRICOLPITES MINOR TETRACOLPORITES ROTUNDOIDES PODOCARPIDITES CLASSICUS FOVEOTRICOLPORITES SP UMBELLIFEROIPOLLENITES SP TRICOLPORITES SP ARECIPITES SP COUPERIPOLLIS SP COUPERIPOLLIS BREVISPINOSUS DICOLPOPOLLIS SP DICOLPOPOLLIS KALEWENSIS PALMAEPOLLENITES SP PALMAEPOLLENITES EOCENICUS PALMIDITES SP PALMAEPOLLENITES OVATUS PALMAEPOLLENITES KUTCHENSIS POLYCOLPITES FLAVATUS COUPERIPOLLIS RARISPINOSUS COUPERIPOLLIS CYMBATUS COUPERIPOLLIS EXERTUS LONGAPERTITES SP PROXAPERTITES SP PROXAPERTITES CURSUS PROXAPERTITES OPERCULATUS MYRICACEOIPOLLENITES SP MYRICACEOIPOLLENITES DUBIUS ZONOCOSTITES SP MARGINIPOLLIS KUTCHENSIS MARGINIPOLLIS SP TRIORITES TUBIFERUS MARGOCOLPORITES TSUKADAI MARGOCOLPORITES SP PSILODIPORITES SP PSILODIPORITES HAMMENII PELLICEROPOLLIS LANGENHEIMII DINOFLAGELLATE CYST CLEISTOSPHAERIDIUM SP SYSTEMATOPHORA SP POLYSPHAERIDIUM SP SPINIFRITES RAMOSUS VAR MULTIBREVIS OPERCULODINIUM SP POLYSPHAERIDIUM SUBTILE HYSTRICHOSPHAERIDIUM SP CORODOSPHAERIDIUM SP RHOPITES SP PROTEACIDITES SP JUGOPOLLIS TETRAPORITES ARAIACEOIPOLLENITES SP GLAPHYROCYSTA SP POLYCOLPITES SP DANDOTIASPORA SP HOMOTRYBLIUM SP		
PROXAPERTITES CURSUS - POLYCOLPITES FLAVATUS ZONE		PALMAEPOLLENITES KUTCHENSIS MARGOCOLPORITES TSUKADAI ZONE	MAGNASTRIATITES HOWARDII - COUPERIPOLLIS RARISPINOSUS ZONE	ZONATION	EXAMINED BY		CHART-15
MIDDLE EOCENE		UPPER EOCENE	OLIGOCENE	AGE			

OLPAD / CAMBAY		ANKLESII-WAR		DADHAR		FORMATION		SYMBOLS		BOSTRATIGRAPHY OF WELL PALE-A	
						MEMBER		11-25 6-10 2-5 26-50			
						LITHOLOGY					
						DEPTH IN METRES					
						CUT T/SWC/CON CORE					
						CYATHIDITES MINOR					
						CYATHIDITES SP					
						CYATHIDITES CEC. AUSTRALIS					
						LYGODIUMSPORITES SP					
						CICATRICOSSPORITES VENUSTUS					
						CICATRICOSSPORITES SP					
						TRILETES SP					
						POVEOTRILETES SP					
						SCABRATRILETES SP					
						MAGNASTRIATITES SP					
						MAGNASTRIATITES HOWARDII					
						POLYPODIACEOISPORITES SP					
						SCABRAMONOLETES SP					
						POLYPODIISPORITES SP					
						POLYPODIISPORITES FORMOSUS					
						POLYPODIISPORITES MINOR					
						LAEVIGATOSPORITES SP					
						LAEVIGATOSPORITES OVATUS					
						PEDIASTRUM SP					
						FUNGAL SPORE					
						PODOCARPIDITES SP					
						PODOCARPIDITES CLASSICUS					
						TRICOLPITES SP					
						TRIPOROPOLLENITES SP					
						TRIPORITES SP					
						TRICOLPITES MINOR					
						MELIAPOLLIS SP					
						PROXAPERTITES SP					
						STEPHANOCOLPITES SP					
						POLYBREVICOLPITES NEYVELII					
						TRICOLPORITES SP					
						POLYCOLPITES PEDALIAEODES					
						UMBELLIFEROIPOLLENITES SP					
						POLYCOLPITES FLAVATUS					
						POLYALACIDITES CLARUS					
						PROXAPERTITES ASSAMICUS					
						STRIACOLPORITES OVATUS					
						POLYBREVICOLPORITES CEPHALUS					
						PSEUDONOTHOPAGIDITES KUTCHENSIS					
						RETITRICOLPORITES SP					
						RHOIPITES SP					
						PALMAEPOLLENITES SP					
						PALMAEPOLLENITES KUTCHENSIS					
						PALMAEPOLLENITES EOCENICUS					
						PALMIDITES SP					
						PROXAPERTITES SRP					
						PROXAPERTITES OPERCULATUS					
						PROXAPERTITES CURSUS					
						ARECIPITES SP					
						LONGAPERTITES SP					
						DICOLPOBOLLIS SP					
						DICOLPOBOLLIS KALEWENSIS					
						COUPERIPOLLIS SP					
						COUPERIPOLLIS RARISPINOSUS					
						COUPERIPOLLIS BREVISPINOSUS					
						MONOCOLPOBOLLISBENOALENSIS					
						ZONOCOSTITES SP					
						MYRICACEOIPOLLENITES SP					
						MYRICACEOIPOLLENITES DURIUS					
						IUGOPOLLIS TETRAPORITES					
						MARGINIPOLLIS SP					
						MARGINIPOLLIS KUTCHENSIS					
						TRIORITES TUBIFERUS					
						MARGOCOLPORITES SP					
						MARGOCOLPORITES TBUKADAI					
						CUPANIIDITES FLACCIDIFORMIS					
						PSILODIPORITES HAMMENI					
						PELLICIEROIPOLLIS LANGENHEIMI					
						OPERCULODINIUM SP					
						CLEISTOSPHAERIDIUM SP					
						POLYSPHAERIDIUM SP					
						POLYSPHAERIDIUM SUBTILE					
						ACHOMOSPHAERA SP					
						SPINIFERITES SP					
						DINOFLAGELLATE CYST					
						HYSTRICHOSPHAERIDIUM SP					
						SPINIFERITESRAMOSUS VAR. MULTIBREVIS					
						CLEISTOSPHAERIDIUM DIVERSISPINOSUM					
						MONOCOLPOBOLLIS SP					
						PROXAPERTITES CURSUS					
						POLYCOLPITES FLAVATUS					
						PC-MT ZONE L. EOCENE					
						PC-MT ZONE U. EOCENE					
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						PC-MT ZONE O. EOCENE					
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						PC-MT ZONE O. EOCENE					

[illegible]

In the Olpad Formation preservation is fair and the diversity of flora is less than Cambay, Ankleshwar and Dadhar Formations. Here the pteridophytes and terrestrial floral elements of angiosperms are common. The phytoplanktons and Gymnosperms are totally absent in this formation.

5.2 Biozonation :

Based on palynofloral studies five successive palynozones are established on the basis of appearance (entry) and disappearance (exit) of diagnostic taxa in the stratigraphic column of Gandhar-A, Pakhajan-A, Dahej-A and Palej-A wells (charts 2.1A, 1B, 1C). The zonation is based on the concepts of oppel zone (assemblage zone characterised in terms of range of numerous fossils as defined by Hedberg (1976). Furthermore, these zones are in accordance with the code of International stratigraphic nomenclature, (1976). The age of each zone is determined by the range of a diagnostic taxa in the stratigraphic column (Thanikaimoni *et al.*, 1984). The well Gandhar-A has been considered for zonation as complete Paleogene sequences are encountered in this well (Charts 1.1A, 1.1B, 1.1C, 1.1D, 1.1E and 1.1F). The biostratigraphic zone in ascending order are as follows:

1. Monocolpopollenites sp - Proxapertites sp assemblage zone (Paleocene).
2. Polybrevicolporites cephalus - Pellicieripollis langenheimii assemblage zone (Early Eocene).
3. Proxapertites cursus-Polycolpites flavatus assemblage zone (Middle Eocene).
4. Palmaepollenites kutchensis-Margocolporites tuskadai assemblage zone (Upper Eocene).
5. Magnastriatites howardii-Coperipollis rarispinosus assemblage zone (Oligocene).

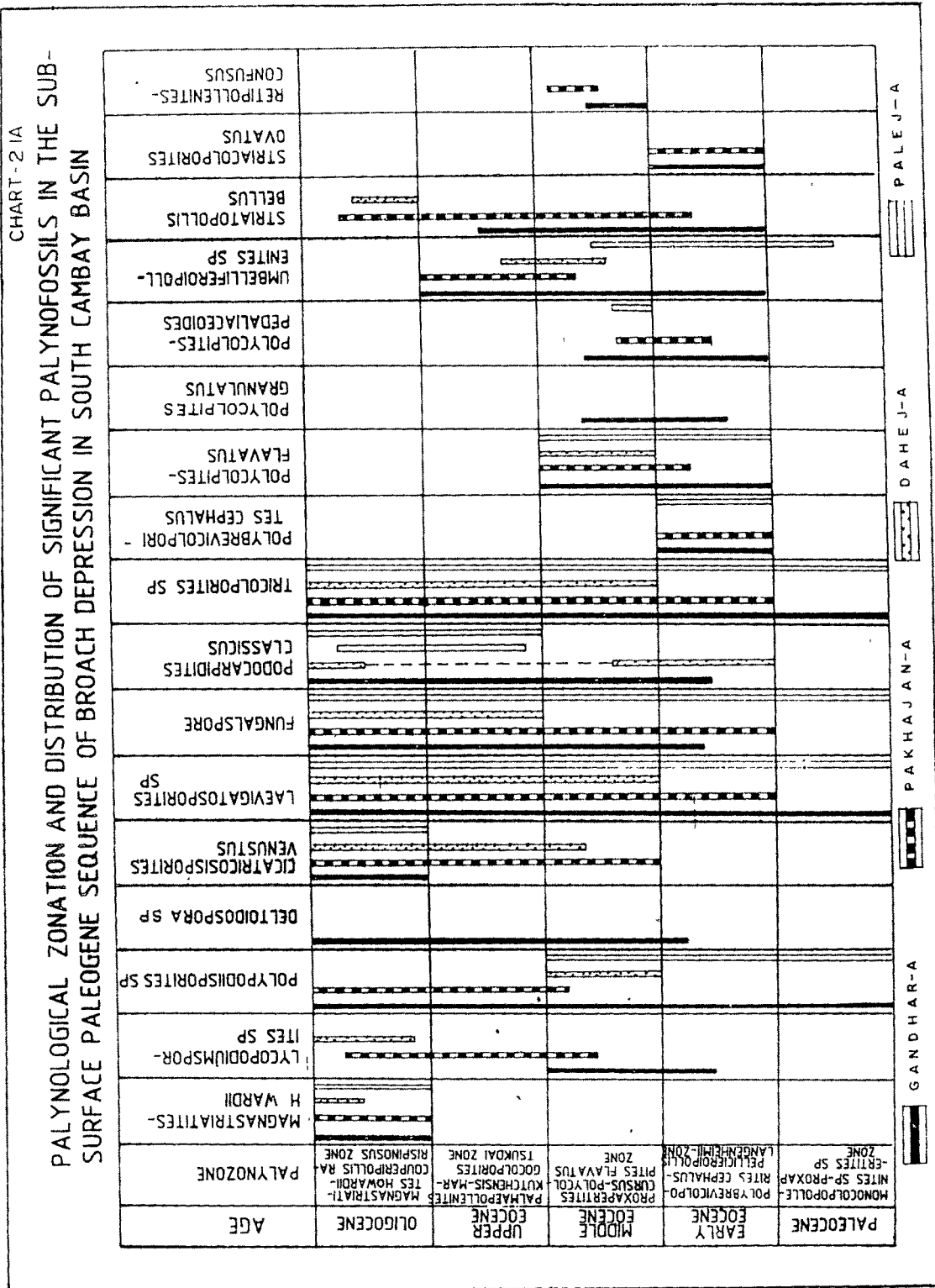
5.2.1 Monocolpopollenites sp-Proxapertites sp assemblage zone :

Reference section: The samples encountered between 4060-4395 m, 1895-2000 m, 1580-1655 m in wells Gandhar-A, Palej-A and Matar-A respectively. This zone could not be marked in wells Gandhar-B,C,D and Pakhajan-A due to well terminated within the Cambay Formation.

Definition : The base of this zone is defined by the entry level of Proxapertites sp, Monocolpopollenites sp, Laevigatosporites sp, Polypodiisporites sp, Longapertites and Psilodiporites hammenii, in wells Gandhar-A and Palej-A (chart 1.1A, 2.1B). The top of this zone is marked by the disappearance (extinction) level of Monocolpopollenites sp and proxapertites sp.

Characterization : The presence of Monocolpopollenites sp and Proxapertites sp is continuously traced from 4060-4395 m in well Gandhar-A and further from 1895-2000 m in well Palej-A. The species made their entry within this zone includes Umbelliferoipollenites sp, Myricaceoipollenites dubius, Pseudonothofagidites kutchensis, Marginipollis kutchensis, Palmaepollenites eocenicus, Proxapertites operculatus, Proxapertites cursus, Palmaepollenites kutchensis and psilodiporites hammenii. The other associated taxa of this zone includes Umbelliferoipollenites sp, Palmaepollenites nadhamuni, Couperipollis sp and Cyathidites minor. These species are continued to occur in the overlying zone also. Among the species of the above assemblage Monocolpopollenites sp and proxapertites sp are restricted in this zone only.

Age : On the basis of stratigraphic position and the overlying Polybrevis



colporites cephalus -Pellicieroipollis langenheimii assemblage zone of Early Eocene age, poorly fossiliferous zone is tentatively assigned to Paleocene age.

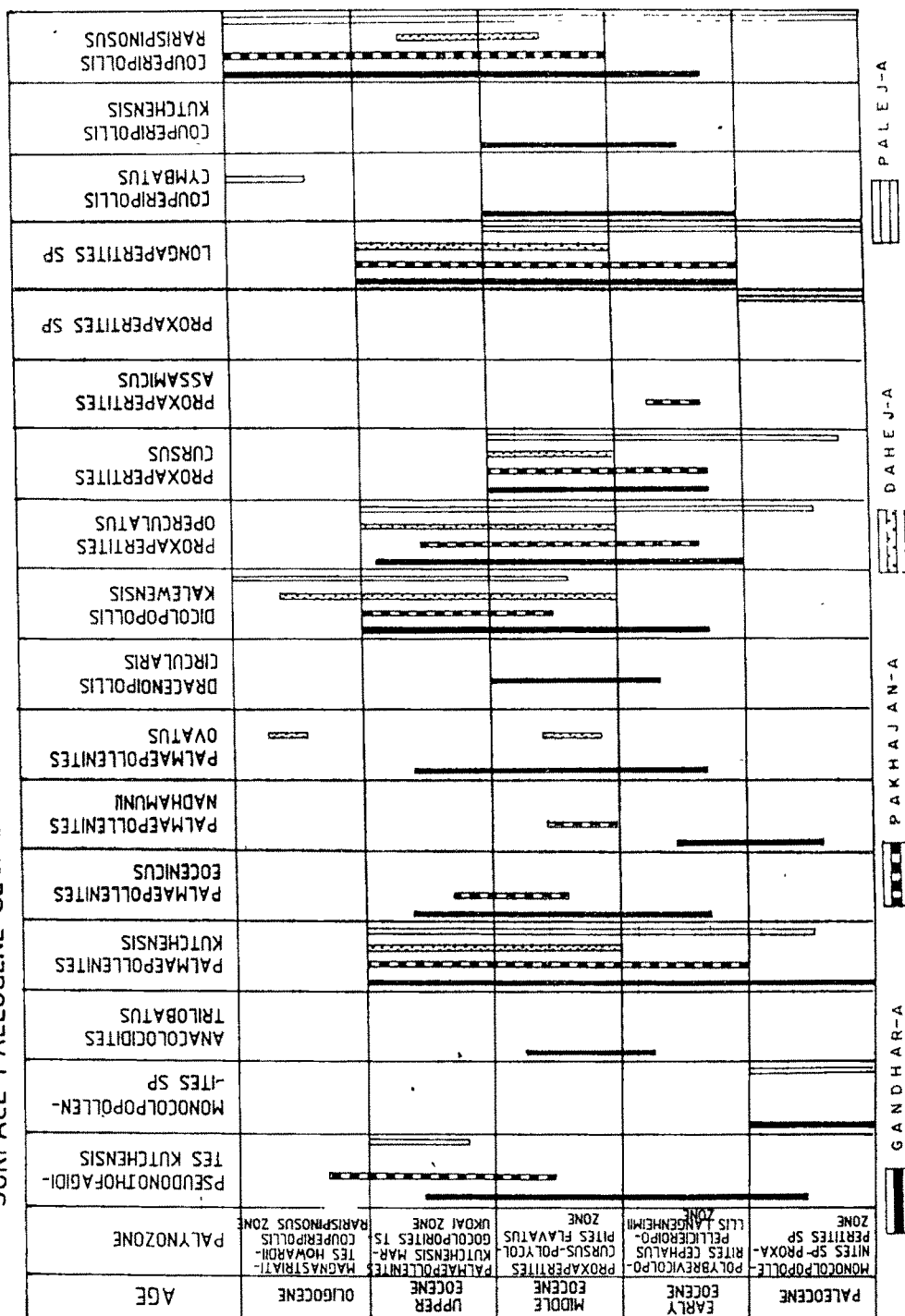
5.2.2 Polybrevicolporites cephalus-Pellicieroipollis langenheimii assemblage zone

Reference section : The samples encountered between 2980-4060 m, 3800-4000m, 1875-1895 m and 1520-1580 m in wells Gandhar-A, Pakhajan-A, Palej-A and Matar-A respectively. This zone could not be defined in well Dahej-A due to the non-availability of samples.

Definition : The Upper limit of this zone is marked by exist of Polybrevicolporites cephalus, Pellicieroipollis langenheimii and Straicolporites ovatus in wells Gandhar-A (2980 m), Pakhajan-A (3800 m) and Palej-A (1875m). The lower limit of this zone is defined by the entry of Polycolpites pedaliaceoides, Polycolpites granulatus, Polybrevicolporites cephalus and Pellicieroipollis langenheimii (Charts 2.1A, 2.1B and 2.1C).

Characterization : The presence of Polybrevicolporites cephalus and Pellicieroipollis langenheimii is continuously traced from 2980 m to 4060 m in Gandhar-A well and further from 3800 m to 4000 m. and 1875-1895 m wells Pakhajan-A and Palej-A respectively. The other significant polynospecies made their first entry in this zone includes Polycolpites pedaliaceoides, Polycolpites granulatus, Striatopollis bellus, Striacolporites ovatus, Anacolosidites trilobatus, Palmaepollenites eocenicus, Palmaepollenites ovatus, Dracenoipollis kutchensis, Arecipites indicus, Zonocostites ramonae, Retidiporites sp, Proteacidites sp, Margocolporites tsukadai and Iugopollis tetraporites.

PALYNOLOGICAL ZONATION AND DISTRIBUTION OF SIGNIFICANT PALYNOFOSSILS IN THE SUB-SURFACE PALEOGENE SEQUENCE OF BROACH DEPRESSION IN SOUTH CAMBAY BASIN



All the above mentioned species are continue to occur in the overlying zone except Polybrevicolporites cephalus, Pellicieroipollis langenheimii and Striacolporites ovatus. These taxa becomes extinct at the top of this zone. The micropolankton which make their first entry in this zone includes Hystriospheraeridium sp, Spiniferites sp, Homotryblum sp and Polysphaeridium subtile.

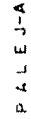
Age : The co-occurrence of Polybrevicolporites cephalus, Pellicieroipollis langenheimii and Striacolporites ovatus in this zone confirm Early Eocene age for this zone. The taxa Pellicieroipollis langenheimii has been reported from Lower Eocene in Kutch (Sah and Kar, 1970), Saxena (1979). Similarly the taxa Polybrevicolporites cephalus has been reported from Lower Eocene of Kutch (Venkatachala and Kar, 1969).

5.2.3 Proxapertites cursus-Polycolpites flavatus assemblage zone:

Reference section : Samples from the interval between 2675 m and 2980 m in well Gandhar-A and from 3560-3800 m, 1730-1875 m in wells Pakhajan-A and Palej-A respectively.

Definition : The upper limit of this zone is defined by the exist level of Proxapertites cursus, Polycolpites flavatus and Psilodiporites hammenii in wells Gandhar-A (2675m), Pakhajan-A (3650m), Daheja-A (3720m) and Palej-A (1730m) and the lower limit of this zone is the upper limit of Polybrevicolporites cephalus -Pellicieroipollis langenheimii assemblage zone (Chart No.2.1A, 2.1B, 2.1C). The lower limit could not be marked in

CHART-21C



DAHEEJ-A

PAKHAJANA-A

3 A M D H A R - 8

well Dahej-A due to non-availability of samples.

Characterization : The diagnostic species recorded in this zone includes Polycolpites granulatus, Polycolpites pedalaceoides, Retipollenites confusus, Anacolosidites trilobatus, and Palmaepollenites nadhamunii. These species become extinct within this zone except Polycolpites flavatus, Proxapertites cursus, Psilodiporites hammenii which extinct at the top of this zone. The species which make their first entry in this zone are Retipollenites confusus, Cicatricosisporites venustus, Glaphyrocysta sp and Hystrichosph-aeridium tubiferous. The other associated taxa recorded in this zone includes Pseudonothofagidites kutchensis, Palmaepollenites ovatus, Palmaepollenites kutchensis, Palmaepollenites eocenicus, Dicolpopollis kalewnesis, Proxapertites operculatus, Longapertites sp, Couperipollis rarispinosus, Lycopodiumsporites sp, Polypodiisporites sp, Deltoidospora sp, Laevigatospora ovatus, Podocarpidites classicus, Umbelliferoipollenites ovatus, Striatopollis bellus, Arecipites indicus, Zonocostites ramonae, Margocolporites tsukadai, Marginipollis kutchensis, Proteacidites sp, Iugopollis tetraporites, Myricaceoipollensites dubius, Spiniferites ramosus var. multibrevis and Polysphaeridium sp.

All the above mentioned species are continue to occur in the overlying zone also except Polycolpites flavatus, Polycolpites pedaliaceoides, Retipollenites confusus and Anacolosidites trilobatus.

Remarks :

Proxapertites cursus is known from Paleocene-Middle Eocene in Caribbean, Bornea (Germeraad et al., 1968), Paleocene-Middle Eocene of Bengal (Baksi, 1962, Baksi and Deb 1960), Paleocene-Middle Eocene of Cambay

(Rawat et al., 1977) and Kutch (Kar 1985). Polycolpites flavatus, Polycolpites granulatus have been reported from Lower to Middle Eocene of Kutch (Sah and Kar 1970, Kar 1978, Kar 1985), Polycolpites pedaliaceoides has been reported from Early Eocene to Cambay (Rawat et al., 1977), Lower to Middle Eocene of Cauvery (Venkatachala and Rawat 1972), Psilodiporites hammenii has been Lower to Middle Eocene of Gujaraat (Varma and Rawat 1963), Paleocene-Middle Eocene of Cauvery (Venkatachala and Rawat 1972), Retipollenite confusus is so far reported from Lower to Middle Eocene of Cambay (Rawat et al., 1977) and Kutch (Kar 1985).

Age : Following the ranges given by the above authors and based on the underlying Polybrevicolporites cephalus-Pellicieripollis langenheimii assemblage zone of Early Eocene age and the overlying Palmaepollenites kutchensis-Margocolporites tsukadai assemblage zone of Upper Eocene age and the extinction of Proxapertites Cursus, Polycolpites flavatus and Psilodiporites hammenii at the top of this zone suggest Middle Eocene age to this zone.

5.2.3 Palmaepollenites kutchensis-Margocolporites tsukadai assemblage zone:

Reference section : Samples from the interval between 2345-2675 m, 3365-3560 m, 2440-270 m and 1705-1730 m in wells Gandhar-A, Pakhajan-A, Dahej-A and Palej-A respectively.

Definition : The upper limit of this zone is defined by the exist level of Proxapertites operculatus, Palmaepollenites kutchensis, Margocolporites tsukadai, Iugopollis tetraporites and Longapertites sp in wells Gandhar-A(2345m), Pakhajan-A(3365m), Dahej-A(2440m) and Palej-A(170m) and lower limit is delineated

by the extinction level of Proxapertites cursus, Polycolpites flavatus and Psilodiporites hammenii (Charts 2.1A, 2.1B, 2.1C).

Characterization : The characteristic palynotaxa recorded from this zone includes Proxapertites operculatus, Palmaepollenites kutchensis, Iugopollis tetraporites, Margocolporites tsukadai, Longapertites sp and Umbelliferoipollenites sp. These species made their extinction at the top of this zone. The palynospecies Palmaepollenites ovatus and Palmaepollenites eocenicus made their extinction within this zone.

The other associated species of the zone includes : Lycopodiumsporites sp, Polypodiisporites sp, Deltoidospora sp, Cicatricosisporites Venustus, Laevigatosporites sp, Arecipites indicus, Zonocostites ramonae, Marginipollis kutchensis, Proteacidites sp, Myricaceoipollenites dubius, Hystrichosphaeridium sp, Spiniferites sp, Homotryblium sp Polysphaeridium subtile and Cleistosphaeridium sp. These species are continue to occur in the overlying zone also.

Remarks :

Palmaepollenites kutchensis is known from Paleocene to Upper Eocene of Kutch (Venkatachala and Kar, 1969 Kar, 1978, Kar and Saxena, 1981). Eocene of Cauvery (Venkatachala and Rawat, 1972), Margocolporites tsukadai has been reported from Eocene of Kutch (Venkatachala and Kar, 1969) Paleocene to Upper Eocene of Garohills (Singh, 1977) and Paleocene-Eocene of Bengal basin (Baksi and Deb, 1980). Proxapertites operculatus has been reported from Paleocene-Eocene of Africa (VonHoeken-Klinkenberg, 1966 Germeraad et al., 1968, Salard-Cheboldaeff, 1977 Adegoke et al., 1978), Paleocene of Columbia (Vander Hammen 1954, 1956b, Vander Hammen and Graciade Mutis, 1965 Muller, 1968), Paleocene of Bornea (Germaraad et al., 1968, Muller, 1968). In India Venkatachala and Rawat, 1972 reported this

species from Paleocene to Upper Eocene sediments of Cauvery Basin Naskar and Baksi (1978) reported this species from Paleocene to Upper Eocene sediments of Rajasthan basin. In Bengal Basin, (Baksi and Deb, 1980) reported this species from Paleocene-Eocene sediments. *Iugopollis* tetraporites has been reported from Upper Eocene-Middle Eocene sediments of Cauvery Basin (Venkatachala and Rawat, 1972), Middle to Upper of Cambay (Rawat et al., 1977).

Age : Following the ranges given by the above authors and based on the underlying Proxapertites cursus-Polycolpites flavatus assemblage zone of Middle Eocene age, overlying Magnastriatites howardii-Couperipollis rarispinosus assemblage zone of Oligocene age and the extinction of Proxapertites operculatus, Palmaepollenites kutchensis, Margocolporites tsukadai, Iugopollis, tetraporites at the top of this zone suggests Upper Eocene age to this zone.

5.2.4 **Magnastriatites howardii-Couperipollis rarispinosus assemblage zone:**

Reference section : The lower limit is defined by the entry of Magnastriatites howardii and extinction level of Proxapertites operculatus Palmaepollenites kutchensis and Margocolporites tsukadai. The Upper limit of this zone is marked by the exist level of Couperipollis rarispinosus in wells Gandhar-A (2200 m), Pakhajan-A (3040 m), Dahej-A (2200 m) and Palej-A (1645 m).

Characterization : The diagnostic taxa recorded in this zone includes Striatopollis bellus, Palmaepollenites ovatus, Pseudonothofagidites kutchensis and Homotryblium sp. These species become extinct at the top of this zone. The other associated species of this zone includes Arecipites

indicus, Zonocostites ramonae, Marginipollis kutchensis, Proteacidites sp, Triporopollenites sp, Cyathidites minor, Podocarpidites classicus, Bombacacidites trilobatus, Stephanocolpites sp, Tricolpites minor and Dicolpopollis kalewensis.

The microplankton which are present in the underlying Palmaepollenites kutchensis-Margocolporites tsukadai assemblage zone namely Polysphaeridium sp, Hystriosphraeridium sp, Spiniferites sp and Cleistosphaeridium sp, are become extinct in this zone.

Remarks :

Couperipollis rarispinosus is shown from Paleocene-Oligocene of Assam (Sah and Dutta 1966, 1968, 1974, Sah and Singh, 1974 Singh et al., 1975), Paleocene to Eocene of Rajasthan (Naskar and Bakshi 1978), Eocene of Bengal (Bakshi and Deb, 1980). Striatopollis bellus is known from L.Eocene to Oligocene of Camerous (Salard-Cheboldaeff, 1975). Pseudonothofagidites kutchensis is known from Paleocene-Eocene, Kutch (Venkaatchala and Kar 1969, Saxena, 1979), Lower Eocene of Cambay (Rawat et al., 1977), Lower Eocene, Gujarat (Koshal, 1980), Paleocene to Eocene of Assam (Singh, 1977a) Eocene of Cauvery (Deb, Bakshi and Ghosh, 1973), Palmaepollenites ovatus known from Paleocene-Oligocene of Kutch (Sah and Kar, 1970) Dicolpopollis kalewensis is known from Early Eocene of Franche (Kdeves, 1968), Eocene of Burma (Potonie, 1960b). In India Rawat et al., (1977) reported this species from Early Eocene subsurface sediments of Cauvery Basin, Mathur and Jain.

Age : Following the range given by above authors and absence of Palmaepollenites kutchensis, Proxapertites operculatus and Iugopollis tetraporites and extinction of Couperipollis rarispinosus, Striatopollis bellus, at the top of this zone and first entry of Magnastriatites howardii in material supports Oligocene age to this zone.