

CHAPTER-III

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3.1 PALEOGENE : RESUME OF THE PREVIOUS WORK

In the present chapter, the author gives a brief resume of the significant contributions made by earlier workers in the field of palynology in India and abroad. The study mainly restricted to Paleogene sediments is presented below :

3.2 WORK DONE IN INDIA

The subsurface Tertiary sediments of Cambay Basin attracted several palynologist, paleontologists and stratigraphers for their abundant fauna and floral contents and also for their hydrocarbon potentials.

Literature survey on the palynological studies for the Cambay Basin indicate that there are only a few such publications which are mostly restricted to descriptions dealing with angiosperms, algae and fungal remains. The chief amongst such workers are : Ghosh et al, 1963; Sen 1964; Srivastava 1967; Varma and Rawat, 1963 and Varma and Srivastava, 1965.

Rawat et al., (1977) studied the palynoflora from the Kadi Formation and recorded rich angiospermous pollen grains especially palm and mangrove floral elements including Clavinaaperturites Psilodiporites, Mauritidites, Proxapertites, Spinizonocolpites, Retibrevivitricolpites, Marginipollis, Retistemphanocolpites, Polycolpites and Striatricolpites etc. and assigned a lower Eocene age to the sequence. Venkatachala et al., (1972) Venkatachala and Chowdhary (1974), Rawat et al., (1974), Mathur and Chowdhary (1974) and Mathur et al. (1974) have published palynological information

about Cambay Basin. Mathur (1986) established three dinoflagellate cyst assemblage zone from Middle Eocene sediments of Kalol Formation, Cambay Basin.

In Kutch Basin, Mathur (1966) for the first time reported palynofossils from Paleocene sediments of Matanomadh Formation.

Mathur (1963), Venkatachala and Kar (1978) have published the palynological information on Naredi Formation of Kutch. The Paleocene palynoflora of Wagad region (eastern Kutch) has been described by Mathur and Pant (1973).

Venkatachala and Kar (1969a) described 45 species belonging to 32 genera of spore & pollen from Eocene sediments of Laki stage, Kutch.

Jain and Tandon (1981) recorded 48 microplankton, taxa from Middle Eocene sediments of south western Kutch.

Kar (1985) described 179 species of spore-pollen from Paleocene, Lower and Middle Eocene, Oligocene and Miocene of Kutch Basin. He established following palynozones for Paleocene-Miocene interval of Kutch Basin. His Matanomadh Formation (Paleocene) is divided into (i) Barrenzone, (ii) Dandotiaspora dilata Cenozone, (iii) Tricolpites minutus Cenozone, (iv) Couperipollis kutchensis Cenozone (v) sponge spicules zones. Naredi Formation (Lower Eocene) has been divided into (i) Lakispollis ovatus Cenozone and (ii) Lygodiumsporites lakiensis Cenozone. The Middle Eocene palynofloral assemblage divided into Proxapertites microreticulatus cenozone for Haradu Formation and Cheilanthoidspora enigmata cenozone for the

Rataria bore core. Maniyara Fort Formation (Oligocene) has been divided into (i) Operculodinium centrocarpum Cenozone, (ii) Trisyncolpites ramanujamii Cenozone, and (iii) Aplanosporites robustus Cenozone Kari Nadi Formation (Miocene) has been divided into (i) Cordosphaeridium cantharellum Cenozone (ii) Striatriletes susannae Cenozone and (iii) Operculodinium israelianum Cenozone.

Saxena and Misra (1990) Recorded 95 palynospecies belonging to different genera of Pteridophytic spores, Angiospermous pollen and Fungal spores from Ratnagiri beds of Sindhu Durg district, Maharashtra.

Jain, Kar and Sah (1973) studied the palynoflora from the Barmer sandstone Formation and they suggested Paleocene age on the basis of significant palynotaxa such as Proxapertites scabratus, Proxapertites microreticulatus, Tricolpites baculatus, Palmaepollenites nadhamunii and Couperipollis wodehousei.

Sah and Kar (1974) described the palynofloral assemblage from palana sediments of Rajasthan which includes Chielanthodspora engimata, C. monoleta, Dandotiaspora plicata, Tricolpites brevis, Couperipollis rarispinosus, Margocolporites sitholeyi, Lakiapollis ovatus and Meliapollis ramanujamii. It resembles closely to the Kadı Formation assemblage, Lower Eocene. Naredi Formation of Kutch (Biswas and Raju, 1973).

Chitalay (1951) studied Paleocene-Lower Eocene palynofloral assemblage from the intertrapean beds exposed near Moligaon Kalan in Chhindwara district, Maharashtra. The flora described by him includes Proxapertites assamicus, Polypodiaceasporites, Palmaepollenites, Couperipollis, Tricol-

pites and Triorites.

Venkatachala and Rawat (1972, 1973) erected following palynozones for Paleocene-Late Miocene intervals of Cauvery Basin .

<u>Tricolareporites echinatus</u>	: Middle-Late Miocene.
<u>Lacrimapollis pilosus</u>	: Lower Miocene
<u>Magnastriatites cauveriensis</u>	: Oligocene
<u>Margocolporites sahanii</u>	: Late Eocene
<u>Anacolosidites trilobatus</u>	: Middle Eocene
<u>Psilodiporites hammenii</u>	: Lower Eocene
<u>Proxapertites hammenii</u>	: Paleocene

Anacolosidites trilobatus zone has been further divided into four subzones : Stephanocolpites octacolpoides subzone, Caprifoliipites discretus subzone, Lugopollis tetraporites subzone. Zonocostites ramonae, Tricollareporites echinatus zone has been further divided into two subzones. Verrucatosporites bellatus subzone Malvaceaerumpollis paucibaculatus subzone.

Later, Venkatachala (1974) once again reviewed the work done by him and his associates on the Mesozoic-Tertiary subsurface sediments of Cauvery Basin.

Rao (1965), Navale (1961), Thiergart and Frantz (1962), Ramanujam (1966, 1966-67) and Deb (1972) has published the data on Cuddalore Sandstone, Neyveli lignite palynoflora. Venkatachala (1973) critically reviewed available palynological evidence on age of cuddalore sandstone and favou-

red an Eocene age.

In Krishna-Godawari Basin, Rawat et al., (1991) established 10 palyno-zones in companion to Pleistocene age.

1. Aquilapollenites bengalensis-Mulleripollis bolpurensis assemblage zone (Companion to Maestrichtian).
2. Mulleripollis bolpurensis - Proxapertites hammenii assemblage zone (Paleocene).
3. Proxapertites hammenii - Psilodiporites hammenii - Spinizonocolpites baculatus assemblage zone (Paleocene-Early Eocene).
4. Psilodiporites hammenii - Spinizonocolpites echinatus - Retistephano colpites williamsii assemblage zone (Early Eocene).
5. Anacolositites trilobatus - Iugopollis tetraporites - Margocolporites sitholei assemblage zone (Middle Eocene).
6. Margocolporites Sahnii-Proteacidites parvus-Retitricolpites clarensis assemblage zone (Late Eocene).
7. Retitricolpites-clarensis - Sapotaceoidapollenites africans assemblage zone. (Late Eocene - Oligocene).
8. Dicolpopollis kalewensis - Zonocastites ramonae assemblage zone (Early Miocene).

9. Zonocostites ramonae - Compositoipollenites minimus-Tricollaraeporite echinatus assemblage zone (Early-Middle Miocene) and
10. Monoporpollenites gramineoides - Polyporina globosa - Osmundacidites sp. assemblage zone(?Mio-Pliocene-Pleistocene).

Rao (1990) recorded 65 species belonging to 65 genera of pteridophytic spore and angiospermous pollen from Eocene-Early Miocene sediments of Arthungal bore-hole, Alleppey district, Kerala and he established following three palynozones :

1. Iriangulorites bellus Cenozoone (Eocene)
2. Crassoiretitriletes vanraadshoovani Cenozoone (Oligocene)
3. Malvacearumpollis bakonyensis Cenozoone (Lower Miocene).

In Bengal Basin, Baksi (1972) erected seven palynological zone representing the Upper Cretaceous, Paleocene to Lower Eocene, Middle to Upper Eocene, Oligocene to Miocene, Mio-Pliocene and Plio-Pleistocene sediments from Bengal Basin.

Deb (1976) identified the following seven palynozones from Upper Cretaceous-Eocene subsurface sediments of Bengal Basin:

1. Aquilapollenites zone
2. Proxapertites operculatus zone
3. Mulleripollis zone
4. Proxapertites cursus zone
5. Monocolpopollenites lepidus zone
6. Trilatiporites biswasii zone
7. Paleocaesalpiaceaeapites eocenicus zone.

Mathur and Chopra (1982) recorded 57 species and 36 genera of the Cryptogamic spores from the Post Paleogene subsurface sediments of the Bengal Basin.

Recently Mathur and Chopra (1987) described 137 species belonging to 93 genera of Angiospermous pollen from Early Paleocene to Pleistocene-Holocene sediments of Bengal Basin.

Palynostratigraphic studies in Assam Basin were initiated by Sahni, Chitnale and Puri (1947), Bakshi (1962) and Biswas (1962). They carried out detail palynostratigraphy of Tertiary sediments in Assam.

Subsequently Sah and Dutta, (1966, 1968, 1974), Dutta and Sah (1970), Bakshi (1965, 1974), Sah and Singh (1974), contributed to the palyno-stratigraphy and paleodepositional environments of Therria (Cherra), Tura and Mikir formations in Assam basin.

Dutta and Sah (1970), Sah and Dutta (1974) erected three distinct palynozones in cherra formation. These are (in ascending order) Proxapertites crassimurus Cenozone, Araliaceoipollenites emendatus Cenozone, Dandotiaspora telonata Cenozone and Palmidites plicatus Cenozone within the Paleocene sequence of Tura Formation and correlated them with the three equivalent biozones of the cherra section.

Bakshi (1962) designated simsang palynological zone-I as representing the palynoflora of sylhet limestone. Its main elements being pollen of palmae and caesalpinaceae together with a large number of hystrichosphaerids. Sah and Singh (1977) have described a scanty assemblage of spore-

pollen from the Siju limestone and later by Sah and Dutta (1968) and Baksi (1974). Sein and Sah (1974) differentiated the Kopili sediments from the overlying Barail sequence in Jowai-Badarpur road section on the basis of Monolites mawkmaensis, Lycopodiumsporites sp and Tricolpites sp.

Baksi (1962, 1974), Sah and Dutta (1968), Sein and Sah (1974) contributed to the palynostratigraphy of the Barail group sediments in Assam Basin.

Salujha et al., (1972, 1974) described 65 species belonging to 42 genera of spore-pollen from Paleogene sediments of Garo and Khasi-Jaintia Hills. Important contributions on Assam palynology have also been made by Salujha et al., (1973), who attempted to differentiate Bhuban and Bokabil formations. Banerjee (1967, 1971) also studied the palynofossils from Tertiary of Assam. Sah and Singh, (1977) studied the palynoflora from the Paleogene sediments and these sediments further demarcated the following subdivisions :

Laisong Foramtion :

Usmundacidites sp

Todisporites sp

Retitricolpites sp

Intrapunctatisporites sp

Iriluciporites sp

Stephanocolpites sp

Meyeripollis sp

Jenam Foramtion :

Cicatricosisporites macrocostatus

Polypodiaceaprites tertiarus

Polypodiisporites speciosus

Polypodiisporites oligocenicus

Favitricolporites complex

Couperipollis rarispinosus

Palmaepollenites communis

Renji Formation :

Cicatricosisporites sp

Tricolpites levis

Todisporites sp

Palmaepollenites communis

and Myeripollis sp

Sah and Dutta (1972) recognised three palynozones in the Cherra Formation of south Shillong plateau, Assam.

1. Nymphaeoipollis crassimurus Cenozoone.
2. Araliaceopollenites reticulatus Cenozoone and
3. Tricolpites reticulatus Cenozoone.

Mehrotra (1981) described eight dinoflagellate species belonging to six genera from subcrop Garampani limestone sediments of north Cachar hills, Assam. Subsequently, Mehrotra and Sah (1982) established five palynozones in Mikir Formation, Lower Assam.

1. Assamialetes macroluminus Cenozoone
2. Dandotiaspora dilata Cenozoone
3. Palmidites plicatus Cenozoone
4. Fovetriletes paleocenicus Cenozoone
5. Palmaepollenites eocenicus Cenozoone

Kar (1990) recorded 28 species belonging to 30 genera from Laisang Formation, 42 species belonging to 49 genera from Jenam Formations of Assam and he established two palynozones (i) Malayaespora costata Cenozoone and (ii) Striatriletes susannae Cenozoone in Laisang Formation, Cyathidites minor Cenozoone, Pinuspollenites crestus Cenozoone in Jenam and Bhuban formations respectively.

Salujha and Kindra (1986) described 70 species belonging to 52 genera of spore-pollen including dinoflagellate cysts and fungal spores from Oligocene-Miocene sediments of Cachar area.

Tripathi (1989) recorded 21 species belonging to different 12 genera of dinoflagellate cysts and fungal spores from Paleocene-Eocene sediments of Towai-Sonapur Road section, Meghalaya.

Palynostratigraphic work in Tripura Basin is confined to Surma (Bokabil) and Tippam group sediments Salujha et al., (1977) have made a study of these sediments from Gohalia anticline structure.

Salujha et al., (1979) erected seven palynozones in Miocene sediments encountered in well Barampura-2 of Tripura. Later Salujha and Kindra

(1981) carried out palynological study of the exposed sediments of the Aharmura Anticline and assigned Miocene to Mio-Pliocene age to these sediments (Salujha et al., (1977, 1978, 1980). Detail palynological studies carried out on exposed sediments in the Gojalia and Tulamura Anticlines in Tripura.

Rao et al., (1985) recorded 24 species belonging to different 18 genera of angiospermous pollen from the Barail (Oligocene) and Surma (Miocene) sediments exposed along Sonapur-Badarpur road section, Jaintia Hills (Meghalaya) and Cachar (Assam).

Singh (1990) described 56 species belong to different 30 genera of pteridophytic spores and angiospermous pollen from the Paleocene sediments of Langrin Coal Field, south Shilong plateau, Meghalaya.

Mathur (1965) reported *pediastrum*, *Botryococcus*, associated with pollen, spores and *Hystriochosphaerids* from Himachal Pradesh and assigned Middle to Upper Eocene age.

Sahjha et al., (1969) studied palynofossils from the Simla hills and recovered a palynofossil assemblage suggesting a Lower Eocene age.

Banerjee (1968), Lukose (1968), Mathur (1972), Nandi (1972) and Singh et al., (1973) have contributed to the palynology of the Siwalik sediments. The Siwalik sediments have been subdivided into Lower, Middle and Upper on the basis of Palynofloral assemblage.

Ghosh and Srivasta (1962) reported from the Upper Eocene-Lower Miocene sediments of Dharamsala, Kangra district.

Venkatachala (1972) also described some palynomorphs from the Dharamsala Formation.

Mathur and Jain (1980) studied a few samples of tuffaceous shales of the Dras volcanics exposed near Shergol, south east Ladakh.

3.3 WORK DONE IN ABROAD

Literature citing for the previous studies carried out abroad during the last three decades on spore pollen including dinoflagellate cysts, Acritarch and Fungal remains of Paleocene to Oligocene age are reviewed in the preceding paragraphs :

Frederikson (1980) described 18 sporomorph zones ranging in age from Lower Paleocene to Upper Oligocene along the South Carolina Gulf Coast. He described in detail 99 sporomorphs for the above stratigraphic intervals, out of these, he proposed three new palynospecies. These includes Nyssa-pollenites paleocenicus, Asculopollis colporatus and Triporopollenites microgranulatus.

Important work on Baltimore cavan at the Atlantic outer continental shelf is known after Bebout (1980) who reported 80 species of Tertiary palynomorphs from Tertiary section of the coast no.B-2 well, Baltimore.

Raymond et al., (1980) recorded 20 palynospecies from the Late Paleocene sediments of piedmont province of Merimether country, Georgia.

Stover et al., (1982) while working on the Bermer Basin of Western Australia recorded Late Middle Eocene to early Late Eocene spore-pollens from the werill-up Formation . They recorded the following species for the first time from western Australia:

Clavatipollenites bremerensis, P.cumulus, P.rugulatus, P.rynthis, P.scitus, Propylipollis tegillis, Tetracolporites palynius, Tricolporites adelaidensis, Triporopollenites apiculatus, T.delicatus and Triporopollenites vargus.

In 1983, Islam described the one new genus, nine new species and two new subspecies of dinoflagellate cysts of Early, Middle Eocene age from Baughurst in London basin and from Early Middle Eocene Bracklesham Group at Bracklesham Bay in the Marupshire basin.

Singate (1983) recorded palynofossils from the well exposed section of Elko Formation in the Adobe range, north of Elko, Nevada. Based on the palynotaxa Platycarya, Pistillipollenites Ilex assigned late Early Eocene to early Middle Eocene age for the Elko Formation.

During 1971, Downie et al., described four distinct dinoflagellate cyst association ranging in age from Paleocene to Oligocene sequence of south east England 1) Hystrichosphaera association 2) Michrystidium association 3) Areoligera association and 4) Wetzeliella association.

Nichols et al., (1978) described six new species of Nomipites in the Early Tertiary, wind river basin, Wyoming such as Momipites Wyomingensis M.maltmanensis, M.vertiflamini, M.actinus, M.anellus and M.leffingwelli.

From the Aquitana basin, southern France, Michoux (1988) described the Eocene Wetzelialia cysts complex belonging to the genera Kissilova, Rhombodinium, Wetzelialla and Wilsonidium.

In the year 1989, Barnett reported 151 palynomorphs belonging to 85 genera from the Mid Tertiary Weaverville Formation, North Western California. The most notable pollens of Betulaceae, Onagraceae, Ericaceae,

Sterculaceae and several groups of gymnosperms. An interesting association of typical Eocene taxa (Pistillipollenites, Bombacaceae, Triumfetta) with Oligocene taxa (compositae, malvaceae, polygonaceae, chenopodiaceae, gramineae) have also been recorded.

Working in Argentina, Zamaloa and Romero (1990) reported spore-pollen from Cullen Formation exposed in the north eastern part of Tierra Del Fuego districts in Argentina. As worked out from their palynofloral studies, the age of the Cullen Formation ranges from Late Eocene to Middle Oligocene. The above formation contain Baculatisporites comaumensis (Cookson 1953), Potonie 1956, Catinipollis gliseltalensis, krutzsch 1966, Crassiorites australlis, Lycopiumsporites eminalus Detman 1963, Malvacipollis argentina, Nottoflagidites suggalei (Couper 1953) Hekel 1972, Phyllocladidites mawsonii 1947 ex Couper, 1953 and Reboulisporites fuegiensis.

Srivastava and Binda (1991) studied Eocene-Oligocene palynomorphs from Shumaysi Formation, Saudi Arabia and recorded Echimonocolpites rarispinosus, Intratroporopollenites, Schliekensis microreticulatus Recemonocolpites facilis, Retiplremitricolpites triangulatus and Spinozonocolpites echinatus from the above formation.

Omar and Teran (1993) carried out the palynofloral studies of the Loscuervos and Mirador formations and assigned Paleocene, Early to Middle Eocene for Mirador Formation and Middle Eocene to Oligocene age for Carbonera Formation.

In the year 1993, Kimyai reported thirty two species of spore and pollen and two of them graminidites scabratus and Arecipites antiochus

from Eocene sediments of Black diamond mines Regional preserve, Contra Costa County California.

Germeraad et al., (1968) made compilation study of Tertiary sediments in some parts of tropical south America, Africa and Asia. They classified the marker species into 1) a restricted number of pantropical marker species 2) a large number of marker species which occurred in both the south America and west African regions, tropical today (transatlantic distribution) and 3) a still greater quantity of species which are of significance only within a single botanical province (intra continental distribution). These three systems of sub-zonation are compared with independent 200 palaeontological time-stratigraphical correlation and discussed in detail with special emphasis on the Caribbean data. Palynostratigraphic zonation proposed by Germeraad et al., (1968) for Senonian to pleistocene age is given on page 54.

Burden and Langillae (1991) established two distinctive palynassemblage zones i.e. (1) Gemmatriletes clavatus-Cicatricosisporites potomacensis zone (GC zone) and (2) Trivetibulopollenites betuloides-pesavis parva zone (TP zone) in the Quakwuit and Cape Searle formations of North east Baffin Island, north west Territories, Canada and they assigned Aptian to Paleocene age for the above zones.

Hopkin, Rutter and Rouse (1972) recorded Early Oligocene spore-pollen from the Rocky Mountain Trench of British Columbia. He recorded the following palynospecies from the above area : Osmunda claytonites Graham 1963, Osmunda irregulites Martin and Rouse 1966, Osmunda sp, Pinus sp, Picea sp, Cedrus perialata Martin and Rouse 1966, Tsuga minisacca Martin and

Rouse 1966, Isuga heterophyllites Martin and Rouse, 1966.

Kaska (1989) established five spore-pollen zones in the Early Cretaceous to Tertiary nonmarine sediments of central Sudan. Early, Middle and Late Cretaceous, Paleogene and Eocene/Oligocene subsurface floral units have also been recognised and palynologically detailed.

Frederiksen and Christopher (1978) reported 24 species belonging to seven genera of triporate pollen from the uppermost Paleogene rocks of the U.S., Dorchester County, South Carolina. The above mentioned seven genera includes Momipites, Plicatopollis, Platycaryipollenites, Platy carya, Subtriporopollenites, Carya and Casuarinidites.

Nichols (1978) established six palynozones in the Paleocene strata of Wind River Basin, Wyoming. The species of Momipites described as new are M.wyomingensis, M.waltmanensis, M.ventifluminus, M.actinus, M.anlus and M.leffingwellii.