

## PALYNOLOGICAL EVIDENCES AND THE TERTIARY SEDIMENTS OF INDIA

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**ABSTRACT**—A brief account of the palynological evidences on Tertiary sediments of India has been given. The data available show that the Cretaceous-Tertiary boundary, though recognisable, can not be sharply demarcated due to insufficient studies carried out so far on the problem. Certain taxa are common to all the basins during a particular period of the Tertiary, while certain taxa are of regional significance, important for correlation within a basin only. At the moment, a sharp demarcation between the Paleogene and the Neogene is evident; the demarcations between Eocene-Oligocene and Miocene-Pliocene are recognisable, though not very sharply, everywhere. The vegetation and climatic conditions existing during the different periods have been suggested alongwith the condition of deposition.

### INTRODUCTION

Palynological investigations on the Tertiary formations of India date back only to the past three decades. Ghosh (1941) for the first time reported the presence of a disaccate conifer pollen from the Eocene of Assam. Sahni, Sitholey & Puri (1947) attempted Tertiary stratigraphic correlation by palynofossils for the first time. Subsequently, Rao and Vimal (1952), Sen (1948), Vimal (1952, 1953) and others carried out palynological studies on the Tertiaries of Assam, Rajasthan

etc. Palynological studies received considerable impetus in connection with the petroleum exploration programme in the country. In the following account, an attempt has been made to evaluate the palynological control in the Tertiary formations of India, based on the data available (Fig. 1).

### CRETACEOUS-TERTIARY

The problem of fixing criteria for demarcating the Cretaceous-Tertiary boundary by palynofossils is unsolved as yet. In India, the

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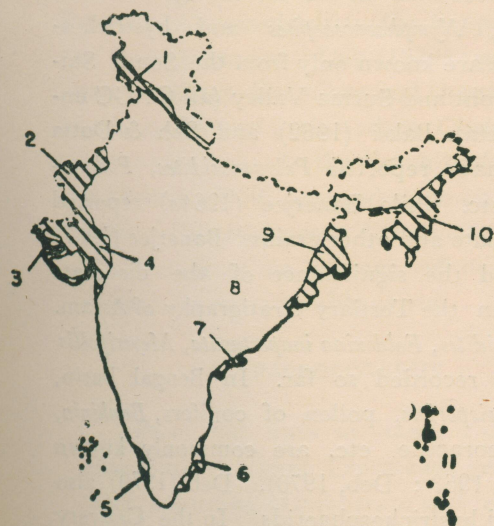
problem as such has not been tackled so far and the published reports on the Upper Cretaceous and Paleocene are not sufficient for establishing markers or indices. It is well known that angiospermic pollen become the dominant element in the Tertiary. These grains, though known from Aptian onwards, constitute a group in the Cretaceous that is subordinate to the gymnosperms and lower group of plants. *Trilobosporites*, *Appendicisporites*, *Aquilapollenites* etc., which are typical in the Cretaceous, are not known in the Tertiary. The Upper Cretaceous of Andaman (Banerjee, 1967b) and Karikal, South India (Banerjee & Misra, 1966) contain Cretaceous taxa like *Caytonipollenites*, *Cycadopites*, *Araucariacites*, *Podocarpidites* etc. in association with angiospermic grains like *Nymphaeaceae*pollenites, *Palmaepollenites*, *Triporites* etc. The flora in Karikal is richer than in Andaman and contain, in addition, *Trilobosporites*, *Classopollis*, *Aquilapollenites*, hystrichosphaerids etc. Sah & Dutta (1968) did not report any palynological assemblage from the Upper Cretaceous of Assam. Biswas (1963) reported pollen grains referred to *Nymphaea*, *Protea*, *Caesalpinia* etc. from the Upper Cretaceous to Middle Eocene of Bengal. From the Paleocene of Assam, Biswas (1962) reported pollen of Sapindaceae, Nymphaeaceae, Rhamnaceae, rare Coniferae etc. and abundant hystrichosphaerids while Sah & Dutta (1966) reported abundant *Palmaepollenites*, *Schizosporis*, *Polygalacitites*, *Retialetes* etc. Mathur (1966) recorded grains of *Schizaea*, Palmae, Proteaceae, Nymphaeaceae, *Polycolpites* etc. in the Paleocene of Kutch.

Palynological data as available from Tertiary (excluding Paleocene) sediments of various Indian basins indicate that certain

taxa are common to all the basins and certain taxa are of regional significance, important for correlation only within a basin. These latter taxa do not necessarily exhibit restricted vertical range of occurrence and may as well be significant statistically (Fig. 2).

### EOCENE

In Eocene sediments of all the basins, *Nothofagidites*, *Polycolpites*, *Palmaepollenites*, *Retipilonaepites*, hystrichosphaerids etc. have been commonly recorded in a rich assemblage of pteridophytic, angiospermous and microplanktonic elements. In Assam, the significant taxa known so far are *Schizosporis* (in reduced frequency), *Biretisporites*, *Anacolosidites*, *Retialetes*, *Paleorubiaceae*pollenites, *Triporites*, *Schizaeoisporites*, *Paleocaesalpiniaepites*, *Nymphaeaceae*pollenites etc. (ONGC unpub. data; Baksi, 1962; Banerjee, 1964b; Biswas, 1962; Ghosh, 1969; Sah & Dutta, 1968). Biswas (1963) reported pollen cf. of *Protea*, *Colocasia*, *Bombax*, *Olax*, *Nymphaea*, *Caesalpinia* etc. from the Eocene of Bengal. From the Eocene of Cauvery basin, the major taxa recorded are *Paleorubiaceae*pollenites, *Nymphaeaceae*pollenites, *Triporites*, *Paleocaesalpiniaepites*, *Schizaeoisporites* etc. (ONGC unpub. data). In the Cambay basin, *Nymphaeaceae*pollenites, *Proteacidites*, *Paleocaesalpiniaepites*, *Cicatricosisporites* etc. are significant taxa in the Eocene (ONGC unpub. data). From the Eocene of Kutch, *Proteacidites*, *Triporites*, *Dicolpites* etc. are known while Mathur (1963) has reported pollen of Pinaceae also. A similar assemblage but without the saccate grains, is known from the Eocene of Rajasthan (Rao & Vimal, 1952). In the Sub-himalayan region, *Proteacidites*, *Nymphaeaceae*pollenites, *Abietinaepollenites*, *Cicatricosisporites* etc. occur in the Eocene as major taxa (ONGC unpub. data; Salujha, Srivastava & Rawat, 1969). In the Paleogene sediments of



1. FRONTAL FOLDED ZONE
2. RAJASTHAN SHELF.
3. KUTCH SHELF
4. CAMBAY GRABEN.
5. KERALA COAST.
6. CAUVERY BASIN.
7. GODAVARI BASIN.
8. ORISSA SHELF.
9. WEST BENGAL SHELF
10. U. ASSAM & S. SHILLONG SHELF
11. ANDAMAN ISLANDS.

Fig. 1

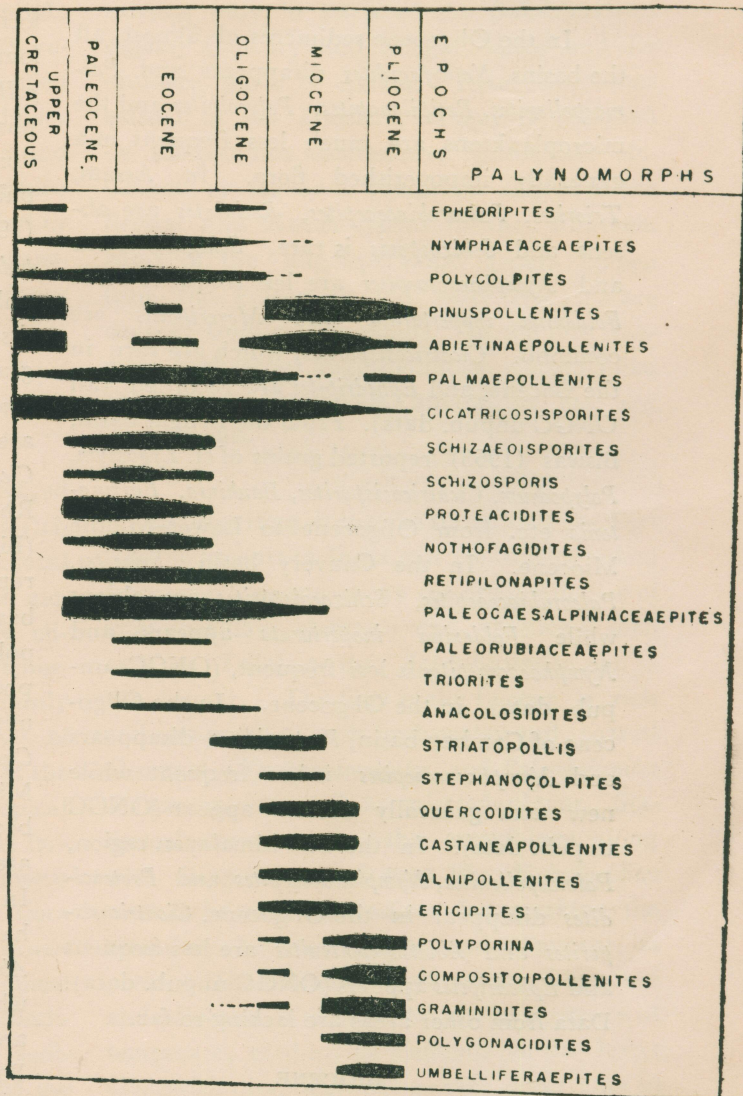


Fig. 2

Fig. 1. Marine Tertiary Basins of India. Fig. 2. Ranges of some Indian Tertiary Palynomorphs.

Andaman, *Schizaeoisporites*, *Cicatricosisporites*, *Nymphaeaceaeapites*, *Tiliaepollenites* etc. are significant (ONGC unpub. data ; Banerjee, 1966).

#### OLIGOCENE

In the Oligocene sediments of almost all the basins, *Nothofagidites* disappears and *Palmaepollenites*, *Retipilonapites*, *Polycolpites* and the microplanktons are much less frequent in a generally impoverished flora. In Assam, *Triorites*, *Paleorubiaceaeapites*, *Retialetes* are absent and *Schizosporis* is rare. *Schizaeoisporites* and *Nymphaeaceaeapites* are less frequent while *Foldexina inaperturata* and *Meyeripollis* are common. *Cicatricosisporites*, which are rare in the Eocene, and *Ephedripites* are recorded (all ONGC unpub. data). From the Bengal basin, Biswas (1963) reported grains of cf. *Lygodium*, *Polypodium*, *Cicatricosisporites*, *Bauhinia*, *Barringtonia* etc. from Oligocene to Lower-Middle Miocene. In the Cauvery basin, *Triorites*, *Paleorubiaceaeapites*, *Schizaeoisporites* are absent while *Foldexina inaperturata* appears and *Nymphaeaceaeapites* is less frequent, (ONGC unpub. data), in the Oligocene. In the Oligocene of Cambay basin, *Proteacidites* disappears and *Nymphaeaceaeapites* is less frequent while new taxa generally do not appear (ONGC unpub. data). In the Sub-himalayan region, *Palmaepollenites*, *Nymphaeaceaeapites* and *Proteacidites* disappear in the Oligocene, *Cicatricosisporites* and *Abietinaepollenites* are less frequent and *Ephedripites* appears (ONGC unpub. data). Data from other areas are lacking so far.

#### MIOCENE

In the Miocene sediments of the basins where from data are available, disaccate conifer grains appear as one of the important constituents in a rich assemblage of temperate to sub-tropical elements. *Palmaepollenites*, *Nymp-*

*haeaceapites* etc., which are conspicuous in the Paleogene, are either absent or occur rarely. In Assam region, *Cicatricosisporites*, *Pinuspollenites*, *Alnipollenites*, *Quercoidites*, *Ericipites* etc. are conspicuous and typical Lower Gondwana forms like *Striatites*, *Verticypollenites* etc. are found associated in the assemblage. *Palmaepollenites*, *Nymphaeaceaeapites* and hystrichosphaerids are known only from the South Shillong Front and Surma Valley (all ONGC unpub. data). Baksi (1962) and Sah & Dutta (1968) have reported *Polygonacidites*, *Podocarpidites* etc. while Banerjee (1964a) reported polycolpate and other grains. Banerjee (1967) discussed the significance of the disaccate grains in the Tertiary stratigraphy of Assam. *Anacolosidites*, *Foldexina inaperturata*, *Meyeripollis* are not recorded so far. In Bengal basin, *Cicatricosisporites*, pollen of conifers, *Bauhinia*, *Rhizophoraceae* etc. are commonly known (Biswas, 1963 ; Deb, 1970). Deb (1970) also reported hystrichosphaerids. In the Cauvery basin, *Ericipites*, *Castanaepollenites*, *Striatopollis*, pollen of conifers etc. appear and hystrichosphaerids are recorded in the Miocene (ONGC unpub. data). *Pinuspollenites*, *Alnipollenites*, *Castanaepollenites*, *Striatopollis* etc. appear in the Miocene of Cambay basin and *Cicatricosisporites* become more frequent while hystrichosphaerids are practically absent (ONGC unpub. data). In the Sub-himalayan region, *Palmaepollenites* has been reported alongwith *Pinuspollenites*, *Abietinaepollenites* etc. from the early Miocene while in the late Miocene, the conifer elements are predominant (ONGC unpub. data ; Banerjee, 1968 ; Lukose, 1969). Data from the other regions are not forthcoming as yet.

#### PLIOCENE

In the Pliocene sediments, pollen grains of herbaceous plants are a major constituent.

These elements appear in the late Miocene. In Assam *Umbelliferaepites*, *Compositoipollenites*, *Graminidites*, *Polyporina* etc, are common, conifers are rare and *Cicatricosisporites* are not recorded while *Quercoidites*, *Castanaepollenites*, *Polygonacidites* etc. continue (ONGC unpub. data). In the Bengal basin, Biswas (1963) reported *Cicatricosisporites*, *Coniferaepites*, pollen of Cyperaceae etc. Deb (1970) reported very rare coniferae, Graminae and Cyperaceae and common Palmae grains while *Cicatricosisporites* is not reported. In the Kutch basin, Mathur & Mathur (1969) reported common *Cicatricosisporites*, *Palmaepollenites*, *Graminidites*, *Polyporina* etc. Data from the Pliocene sediments of other regions are not available as yet.

#### PALEOECOLOGY

From the data at hand, it is envisaged that during Upper Cretaceous period a rich flora consisting of temperate and sub-tropical elements like *Palmaepollenites*, *Proteacidites* etc. existed in a dry sub-tropical to temperate climate in India. The paucity of hystrichosphaerids etc. indicate deposition in mostly fresh-water conditions. With the onset of Tertiary times, the temperate aspect of the flora changed and tropical to sub-tropical element like *Palmaepollenites* etc. became frequent while the disaccate conifer elements were practically unrepresented. The flora during the Eocene period was luxuriant, growing in a warm, humid tropical to sub-tropical climate. Shallow-marine to brackish conditions existed during deposition of the sediments. At the close of the Eocene period the flora became impoverished, presumably due to onset of drier conditions as is evidenced by xeric elements like *Ephedripites* etc. in the Oligocene, though tropical to sub-tropical climate continued. The depositional conditions be-

came more brackish than shallow-marine. In the Miocene, the climate changed to cool, sub-tropical to temperate and the flora was rich. The sediments are mostly fresh-water continental deposits, brackish to lagoonal conditions existing only in parts of the Sub-himalyan region, Cauvery and Bengal basins and the southern parts of Assam. Drier conditions existed in the Pliocene, as may be reasoned by the common occurrence of *Graminidites* etc. Coastal or lagoonal conditions existed in the Bengal and Kutch basins in the Pliocene. Most of the angiospermous genera known from the Paleogene and early Neogene are derived from woody plants. In the late Neogene, herbaceous angiospermous elements like the grasses, chenopods, amaranths etc. are conspicuous.

Summarising, it may be stated that the Tertiary sediments in India can be distinguished from the Cretaceous by the predominance of angiospermous elements and absence of such taxa as *Trilobosporites*, *Appendicisporites* etc. in the former. The flora in the Eocene is rich and composed of both fresh-water and coastal elements (*Nymphaeaceaeapites* and *Palmepollenites* for example) as well as microplanktons. Statistical variations in the assemblage along with disappearance of taxa like *Nothofagidites* seem to be more convenient for marking the boundary between Eocene and Oligocene, at present. The boundary between the Oligocene and Miocene is marked by the appearance of temperate, cold-loving elements in the latter alongwith disappearance or rare occurrence of Paleogene forms like *Nymphaeaceaeapites*, *Triorites* etc. In the Pliocene, herbaceous elements alongwith grains of such advanced families as Graminae, Compositae etc. are conspicuous in the assemblage. Further sub-divisions of the

Tertiary strata into finer zones will have to wait till more data and detailed studies are forthcoming.

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