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Indian Tertiary palynology: Its growth and development*

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ABSTRACT

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The Tertiary palynology made its beginning in India in 1941. An attempt has been made here to summarize the information generated so far on the Tertiary palynology in various Indian sedimentary basins and to analyze its growth since its beginning. The first two decades (1941-1960) witnessed publication of only 14 papers, mainly devoted to description of palynofossils from Indian Tertiary sediments. The first attempt to utilize palynofossils in biostratigraphy of Early Tertiary sediments of north-east India was made in 1962. This paved the way for many more such studies in other areas in future. The analysis has been made of decade-wise publications and also decade-wise trend of growth in number of publications. It is noted that among the institutions, the Birbal Sahni Institute of Palaeobotany, Lucknow has been the major contributor followed by Oil and Natural Gas Corporation and others (including Osmania University, Wadia Institute of Himalayan Geology, Geological Survey of India and various other universities and institutions). Contributions made by these institutions were also analyzed. An effort has been made to analyze publications, subject-wise, e.g. palynostratigraphy, depositional environment, palaeoecology/palaeogeography morphology/nomenclature, review/general papers, etc. Altogether, 517 papers have so far been published. Of these, maximum are from Assam-Meghalaya followed by Gujarat, Himachal Pradesh, Tamil Nadu, Kerala, Rajasthan, etc. Age-wise, maximum papers are published on Palaeocene-Eocene, followed by Miocene, Oligocene and Pliocene. A good number of papers do not provide precise geologic age and are categorized as Palaeogene, Neogene and Tertiary. Interestingly, maximum papers on Tertiary palynology are published in The Palaeobotanist, followed by Geophytology, Current Science, Journal of the Palaeontological Society of India, etc. In spite of a large number of papers published so far on Indian Tertiary palynology, there are gaps to be filled. An effort has been made to identify such gaps and suggestions have been given for future studies.

Key-words: Palynology, palynostratigraphy, depositional environment, analysis, Tertiary, India.

INTRODUCTION

During the last few decades, importance of palynological studies in oil and coal explorations, biostratigraphy, correlation and dating of sedimentary sequences, palaeoenvironmental interpretations, reconstruction of past vegetation, evolution of morphographic characters, etc. has been well recognized. This resulted in generation of huge amount of palynological data from different Indian Tertiary sediments (Text-figure 1) and enormous and rapid growth in literature pertaining to this subject.

In the present paper, an attempt has been made to summarize the information generated on the Tertiary palynology in various Indian sedimentary basins during the last seventy-five years and to analyze its growth on the basis of published papers on various aspects of palynology. The analysis presented here includes studies on Tertiary spores and pollen and their applications.

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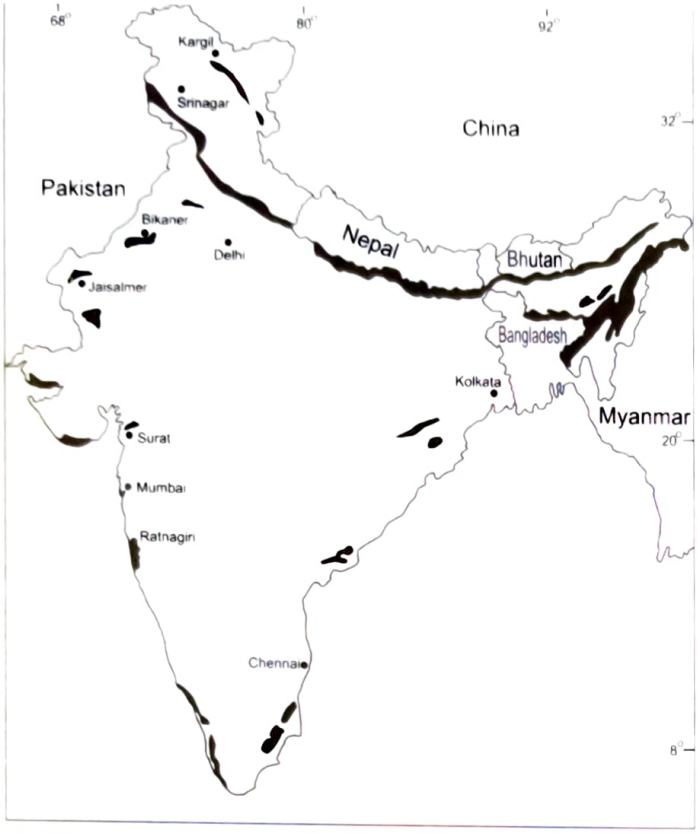


Text-figure 1. Map of India showing distribution of Tertiary exposures.

However, it does not include studies on fossil algae, fungi and organic matter.

TERTIARY PALYNOLOGY IN INDIA

Palynological information from the Indian Tertiary sediments has been published from five distinct areas: i. Northern India (Jammu and Kashmir, Haryana, Himachal Pradesh, Punjab, Uttarakhand and Uttar Pradesh); ii. Eastern and north-eastern India (Arunachal Pradesh, Assam, Bihar, Jharkhand, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal); iii. Southern India (Andhra Pradesh, Goa, Karnataka, Kerala and Tamil Nadu); iv. Western India (Gujarat, Maharashtra and Rajasthan); and v. Central India (Madhya Pradesh). In addition, some information is available from offshore basins, e.g. Bombay Offshore, Krishna-Godavari Basin, Cauvery Basin and Andaman and Nicobar Islands (Text-figure 1). A decade-wise account of the palynological studies on the Indian Tertiary surface and subsurface sediments is summarized below. Major conferences, in which papers related to Tertiary palynology were presented and published, are also mentioned.

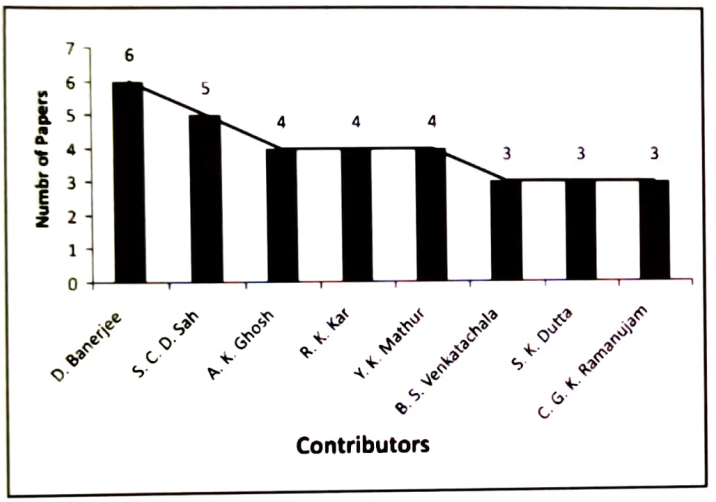
The Beginning: The Tertiary palynology made its beginning in India in 1941 with a short paper on single coniferous, bisaccate pollen from the Tertiary rocks of Assam (Ghosh 1941).

Decade 1 (1941-1950): Altogether, 5 papers were published in this decade (1941-1950). Palynological work in Assam was initiated under a project sponsored by Burmah Oil Company, in connection with an oil exploration programme, and a short, yet significant, report was published by Sahni et al. (1947). Sen (1948) recorded some microfossils from the Early Tertiary coal seams of Laitryngew, Meghalaya. Rao and Vimal (1950a, b) were the first to provide description of palynofossils from Palana lignite, Rajasthan.

Decade 2 (1951-1960): The second decade (1951-1960) witnessed publication of 9 papers. Rao and Vimal (1952), Vimal (1953) Ramanujam (1960) and Potonié and Sah (1960) described palynofossils from lignite deposits of Kerala. Chitaley (1951, 1957) described spores and pollen from the Intertrappean beds of Mohgaon Kalan, Madhya Pradesh. Meyer (1958) published palynological study from Nahorkatiya, Assam whereas Trivedi (1959) reported *Acacia* pollen from tuffaceous limestone near Udaipur, Rajasthan. This decade also witnessed publication of first volume of the journal **"The Palaeobotanist"** in 1952. It is the second oldest journal of palaeobotany, only next to Palaeontographica, and is now 63 years old.

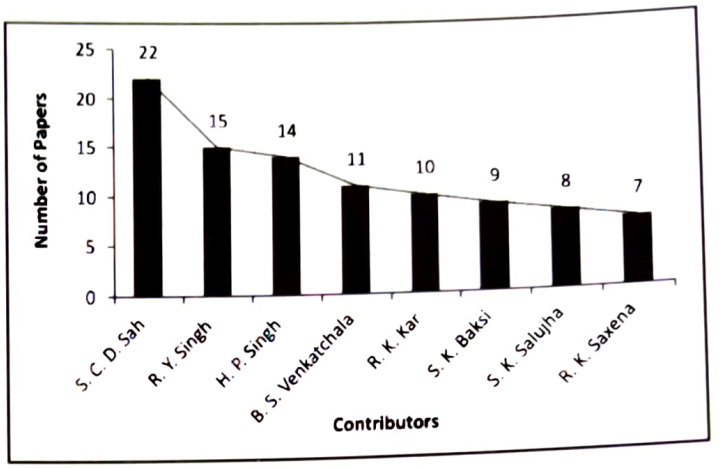
Decade 3 (1961-1970, Text-figure 2): In this decade (1961-1970), 36 papers were published on the Tertiary palynofloras from the following areas: Meghalaya-Assam (Ghosh & Banerjee 1963, Bose 1964, Ghosh et al. 1964a, b, Banerjee 1964a, b, Ghosh 1969, Baksi & Venkatachala 1970), Kutch (Mathur 1963, 1966, Venkatachala & Kar 1968, 1969, Mathur & Mathur 1969, Sah & Kar 1969, 1970, Mathur et al. 1970), Himachal Pradesh (Ghosh et al. 1963, Banerjee 1968, Salujha et al. 1969, Nandi & Bandyopadhyay 1970), Bengal Basin (Deb 1970), Rajasthan (Trivedi 1962), South India (Navale 1962, Thiergart & Frantz 1963, Ramanujam 1966, 1967), Kashmir (Thiergart & Frantz 1962), Andaman Islands (Banerjee 1966) and Bihar (Lukose 1968). This decade also witnessed beginning of palynological studies, based

on measured stratigraphic sections for their application in biostratigraphy, in north-eastern India (Biswas 1962, Baksi 1962, Sah & Dutta 1966, 1968, Dutta & Sah 1970). Biswas (1962) published palynostratigraphy of Mahadeo, Langpar, Cherra and Tura formations (Late Cretaceous-Eocene). Baksi (1962) carried out palynological investigation of Tertiary sequence along Simsang River Section in Meghalaya and designated informal biozones. Detailed palynostratigraphic study of Tertiary sediments, particularly of the Cherra Formation, was published by Sah and Dutta (1966, 1968) and Dutta and Sah (1970).



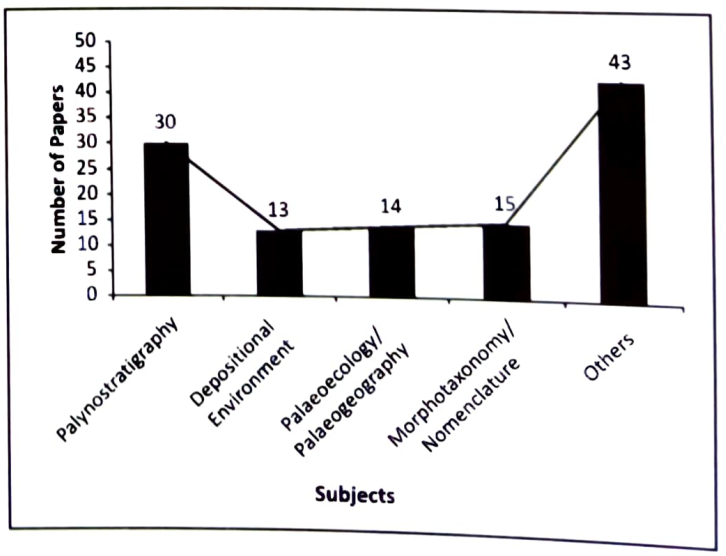
Text-figure 2. Top eight contributors during 1961-1970.

Decade 4 (1971-1980, Text-figures 3-4): This decade witnessed publication of 115 papers, including 40 papers in several conference proceedings. This decade marks active palynological research on subsurface sediments, mainly by ONGC. Dutta & Singh (1980) studied palynostratigraphy of Siwalik equivalents in Arunachal Pradesh whereas Bhandari et al. (1977) studied stratigraphy and palynology of Ladakh Molasse Group in Kargil area of Jammu and Kashmir. Palynological studies were carried out on Palaeocene-Oligocene sediments of Kutch (Kar 1978, 1979, Saxena 1980), Subathu Formation (Eocene) of Himachal Pradesh (Khanna & Singh 1979, Khanna et al. 1979) and Tura Formation (Palaeocene-Early Eocene) of Garo Hills, Meghalaya (Sah & Singh 1974, 1980). Subsurface palynological studies were made in Upper Assam (Banerjee et al. 1973, Banerjee & Uniyal 1980), north of Saraswati River and Dabka, Gujarat (Singh et al. 1980, Koshal 1980), Jaisalmer, Rajasthan



Text-figure 3. Top eight contributors during 1971-1980.

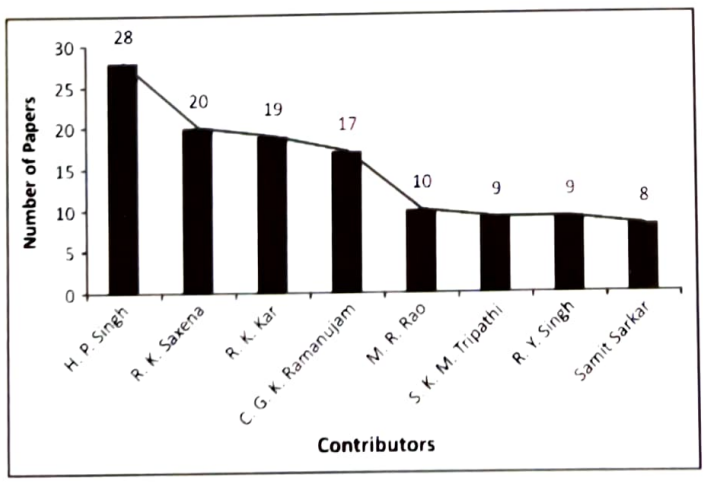
(Lukose 1974), Cambay Basin (Rawat et al. 1977, Mathur & Chowdhary 1977), Garo Hills, Meghalaya (Singh et al. 1976), Cauvery Basin (Venkatachala & Rawat 1972, 1973), Bengal Basin (Baksi 1972, 1973, 1974) and Tripura (Salujha et al. 1977, 1979, 1980). This decade also witnessed BSIP's Silver Jubilee Conference held in November 1971 (13 papers published on Tertiary palynology) and 4th International Palynological Conference held at BSIP in December 1976-January 1977 (10 papers published on Tertiary palynology). An important event of this decade was beginning of publication of **"Geophytology"** by The Palaeobotanical Society, Lucknow. Volume 1, number 1 of this journal was issued in July 1971. Proceeding of the Seminar on Paleopalynology and Indian Stratigraphy, Kolkata, 1971 was published in 1972 by Botany Department, Calcutta University, Kolkata in



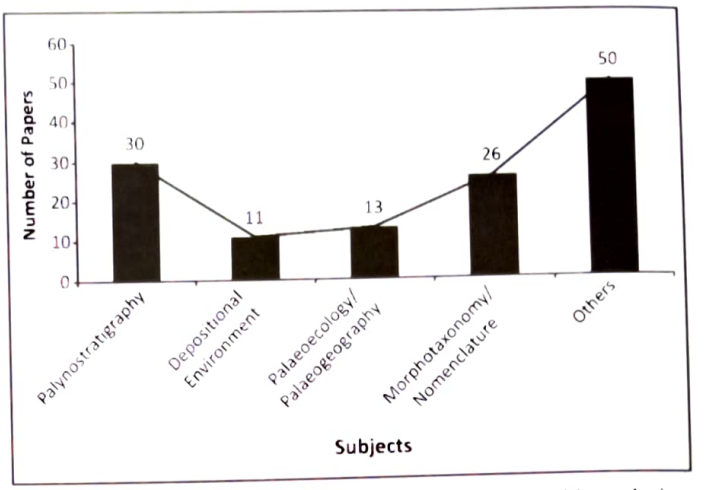
Text-figure 4. Number of papers dealing with various subjects during 1971-1980.

which 8 papers related to Tertiary palynology were published. Similarly, Proceeding of the 4th Colloquium on Indian Micropalaeontology and Stratigraphy, Dehradun, 1974-75 was published in 1977 by Oil & Natural Corporation (ONGC), Dehradun, in which 6 papers related to Tertiary palynology were published.

Decade 5 (1981-1990, Text-figures 5-6): This decade witnessed Tertiary palynology in full bloom and publication of 130 papers. The important contributions on Tertiary palynology in this decade were published on Palaeocene of Meghalaya (Kar & Kumar 1986), Palaeocene-Eocene of Jaintia Hills, Meghalaya (Tripathi & Singh 1984), Mikir Formation of North Cachar Hills, Assam (Mehrotra & Sah 1981, Mehrotra 1981), Barail (Oligocene) of Assam and Meghalaya (Singh et al. 1985), Barail (Oligocene)-Surma (Early Miocene) sediments of Jaintia Hills, Meghalaya (Saxena et al. 1987), Matanomadh Formation (Palaeocene) of Kutch (Saxena 1981), Tertiary palynostratigraphy of Kutch (Kar 1985), palynozonation of Palaeocene of western Rajasthan (Singh & Dogra 1988), Cenozoic palynofossils and vegetation of north and north-western Sub-Himalayan region (Mathur 1984), Subathu Formation (Eocene) in the Banethi-Bagthan area, Himachal Pradesh (Sarkar & Singh 1988), Palaeocene biostratigraphy (Saxena 1988), taxonomy and nomenclature of Indian Tertiary polycolpate pollen (Saxena 1982), Tertiary angiospermous pollen from India and their relationship with African Tertiary pollen (Thanikaimoni et al. 1984, Venkatachala et al. 1989). Studies on the subsurface Tertiary sediments were carried out in Cambay Basin (Koshal & Uniyal 1984, Koshal 1988), Narsapur Well, Godavari-Krishna Basin (Venkatachala & Sharma 1984, Sharma 1988), Jorajan Well-3, Upper Assam (Singh & Saxena 1984), Moran and Nahorkatiya wells, Upper Assam (Nandi 1981), Ramshahr Well No.1, Himachal Pradesh (Singh & Sarkar 1984), Rataria Borehole, Kutch (Kar & Saxena 1981), Arthungal Borehole, Kerala (Rao 1990) and Tripura (Salujha & Kindra 1984, Kar 1990). Major conference proceedings of this decade (in which papers related to Tertiary palynology were published) are: Symposium on Evolutionary Botany and Biostratigraphy Calcutta 1979 (Proceedings published in 1984), 10th Colloquium on the Indian Micropalaeontology and Stratigraphy Pune 1982 (Proceedings published in 1984) and Fifth All India Symposium on Palynology, Nagpur, 1979 (Proceedings published in 1989).

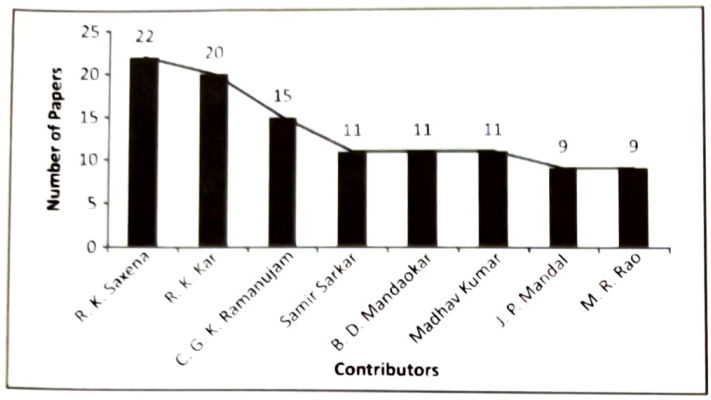


Text-figure 5. Top eight contributors during 1981-1990.

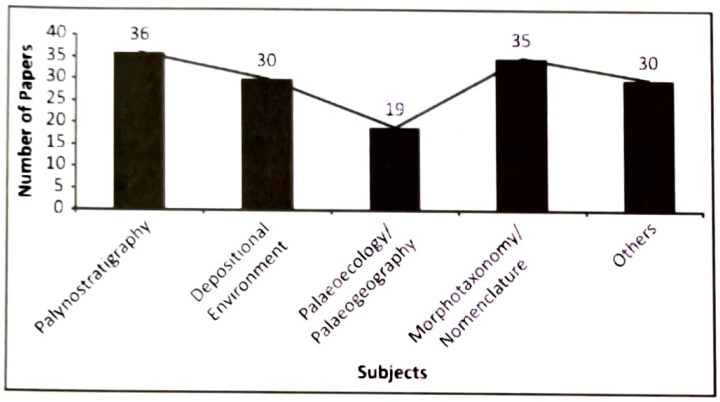


Text-figure 6. Number of papers dealing with various subjects during 1981-1990.

Decade 6 (1991-2000, Text-figures 7-8): This decade marks intensive palynological research at the Birbal Sahni Institute of Palaeobotany Lucknow, Oil & Natural Corporation (mainly subsurface), Wadia Institute of Himalayan Geology, Dehradun and various universities. As a result, 150 papers were published. Some of the selected papers published in this decade are on the terminal Eocene events in north-east India (Kar 2000), Tertiary sediments along the Silchar–Haflong Road, Assam (Kumar 1993), Tertiary sediments of southern Assam (Kumar & Takahashi 1991), Boldamgiri Formation (Early Miocene), Garo Hills, Meghalaya (Saxena & Rao 1996), Siju Formation



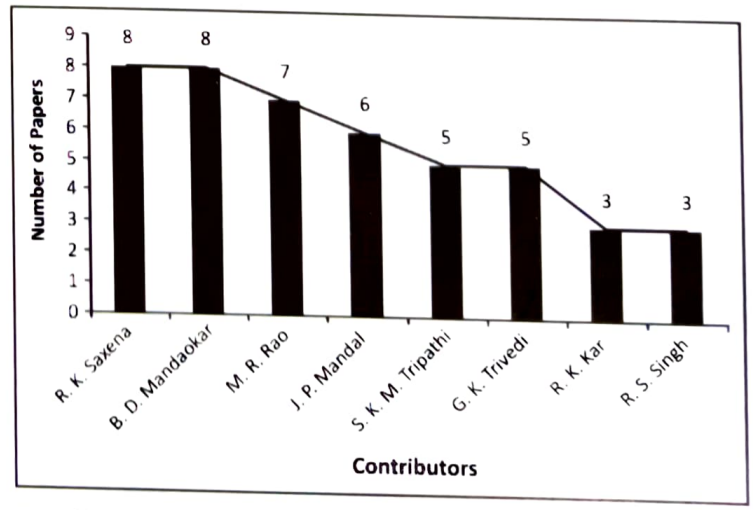
Text-figure 7. Top eight contributors during 1991-2000.



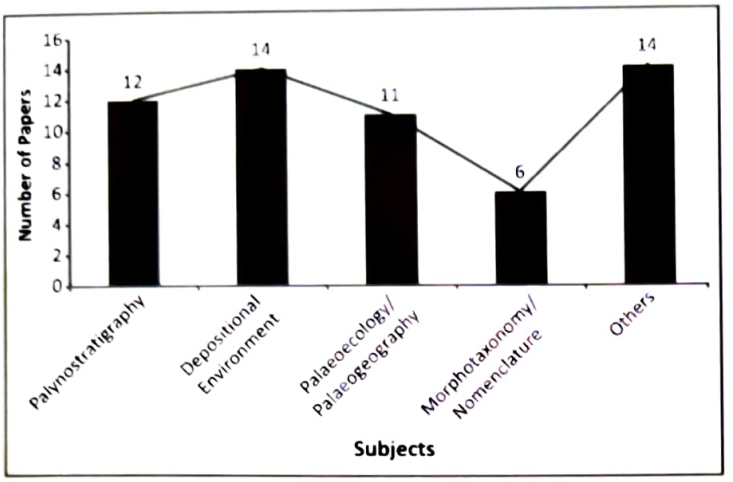
Text-figure 8. Number of papers dealing with various subjects during 1991-2000.

(Middle Eocene), Garo Hills, Meghalaya (Saxena & Sarkar 2000), stratigraphic palynology and Tatrot/ Pinjor Boundary in Sirmaur, Himachal Pradesh (Phadtare et al. 1994), Eocene-Early Miocene sequence in Alleppey, Kerala (Rao 1995), organic composition, age and depositional pattern of Neyveli lignite, Cauvery Basin (Singh et al. 1992) and critical assessment of Indian Tertiary angiosperm pollen (Venkatachala et al. 1996). Studies on the subsurface sediments have been published on Early Eocene of Mannargudi area, Tamil Nadu (Acharya 2000), Paleogene Khamboi-B Well, Mehsana Block, Cambay Basin (Alat et al. 2000), Paleogene of Jambusar, Dabka area, South Cambay Basin (Gupta et al. 1996), Upper Assam Basin (Kar et al. 1994), Oligocene-Miocene of Surat Depression (Mehrotra et al. 1995), Mynagapalli, Kerala (Ramanujam et al. 1991), Miocene of Krishna-Godavari Basin, Andhra Pradesh (Ramanujam et al. 1998), Pattanakad well, Kerala (Ramanujam et al. 1991), Kulasekharamangalam Well, Kerala (Rao 1995), Late Palaeocene Bikaner, Rajasthan (Sharma 2000) and Palaeocene-Eocene, Barmer, Rajasthan (Tripathi 1994, 1995). Saxena (1991) published a catalogue of Tertiary spores and pollen recorded during 1971-1988. Major conferences held during this decade (in which papers related to Tertiary palynology were published) are: Technology Trends in Petroleum Industry (Proceedings published in 1993), International Conference on Global environment and diversification of plants through geological time at Allahabad (Proceedings published in 1995), Conference on Integrated Exploration - Research Achievements and Perspectives (Proceedings published in 1991), Symposium on Recent Advances in Geological studies of North-west Himalaya and the Foredeep (Proceedings published in 1996).

Decade 7 (2001-2010, Text-figures 9-10): This decade witnessed publication of 57 papers as against 150 in the previous decade. The important contributions on Tertiary palynology in this decade were published on palaeoecology of Deccan Intertrappeans (Kar & Singh 2007), palynostratigraphy of Late Palaeocene-Early Eocene sediments of Rajasthan (Kar & Sharma 2001), age, palaeoecology and depositional environment of Vastan lignite, Gujarat (Mandal & Guleria 2006), taxonomic revision of tricolpate pollen (Mandal & Rao 2001), palynostratigraphy and palaeoenvironment of the Upper Bhuban Formation (Early Miocene) of Diltlang, Mizoram (Mandaokar 2008), palynostratigraphic zonation of the Tertiary sediments of Kerala Basin (Rao 2001), palynofloral study of the intertrappean bed exposed at a new locality in Kutch District, Gujarat (Saxena & Ranhotra 2009), palynological investigation of the Kopili Formation (Late



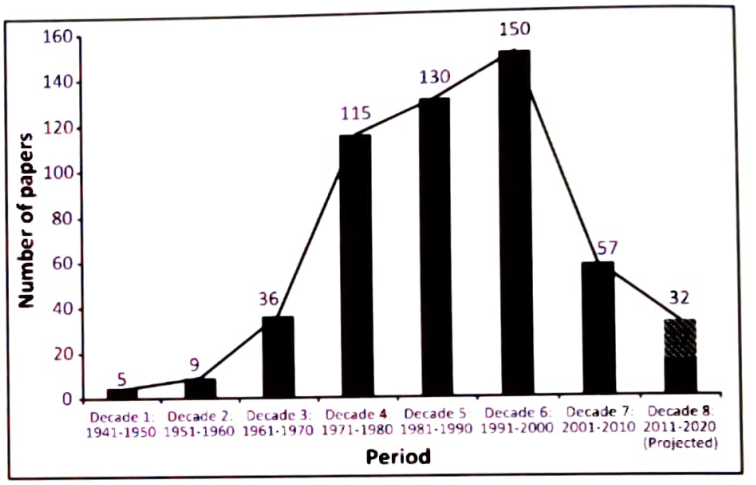
Text-figure 9. Top eight contributors during 2001-2010.



Text-figure 10. Number of papers dealing with various subjects during 2001-2010.

Eocene) in North Cachar Hills, Assam (Saxena & Trivedi 2009) and palynostratigraphy and palaeoenvironment of the Subathu Formation of Dharampur area, Himachal Pradesh (Singh et al. 2007). Palynostratigraphic information from subsurface Tertiary sediments has been published from Early Tertiary of Ganga Basin (Gupta et al. 2003), Upper Assam Basin (Kumar et al. 2001), Oligocene-Miocene sediments, West Bengal (Mandal & Vijaya 2004), Early Eocene sediments in Tiruvarur District, Tamil Nadu (Rao 2009), Jayamkondacholapuram Well 12, Tiruchirapalli District, Tamil Nadu (Saxena & Khare 2004), Palaeogene sediments in western part of Ahmedabad Block, North Cambay Basin (Shanmukhappa & Uniyal 2008) and Panna Formation, Bombay Offshore (Mehrotra et al. 2001a, b). Saxena and Trivedi (2006) published a catalogue of Tertiary spores and pollen, recorded during 1989-2004, supplementing the earlier catalogue (Saxena 1991). This decade witnessed some conferences at BSIP, viz. National Conference on Biodiversity - Past and Present (November 2002), Diamond Jubilee National Conference on Challenges in Indian Palaeobiology: Current status, recent developments and future directions (November 2005), Diamond Jubilee International Conference on changing scenario in Palaeobotany and allied subjects (November 2006), XXI Indian Colloquium on Micropaleontology and Stratigraphy (November 2007) and National Conference on Plant Life through the Ages (November 2008).

Decade 8 (2011-continuing): In this decade, 15 papers have been published so far and it is estimated that altogether, 32 papers will be published by the end of 2020 (Text-figure 11). The most important of these is "Seven decades of Indian Tertiary spore–pollen floras: A Compendium" (Saxena & Tripathi 2012). This provides synopses of 499 publications on Indian Tertiary palynology published during 1941 to 2010, arranged in alphabetical order according to author's surnames. Saxena (2011) validated 2 genera and 39



Text-figure 11. Decade-wise number of papers.

species, which were previously, but not validly, published. Saxena (2013) published 18 new combinations in the genus *Hammenisporis*. Singh (2015) published palynostratigraphic study of the Akli Formation (Palaeocene-Early Eocene) of Barmer, Rajasthan whereas Mandaokar (2015) recorded a rich palynoflora from the Bhuban Formation (Early Miocene) of Amarpur, Tripura and recognized 3 palynozones therein. In November 2013, the Palaeobotanical Society organized "National Conference on Recent Developments in Plant and Earth Sciences".

ANALYSIS

A decade-wise analysis of the growth of Indian Tertiary palynology during the last seventy-five years is presented below. Starting from 1961, top eight contributors, in terms of number of publications, are presented for each decade in Text-figures 2, 3, 5, 7 and 9. Similarly, subject-wise publications in each decade (starting from 1971) are presented in Text-figures 4, 6, 8 and 10.

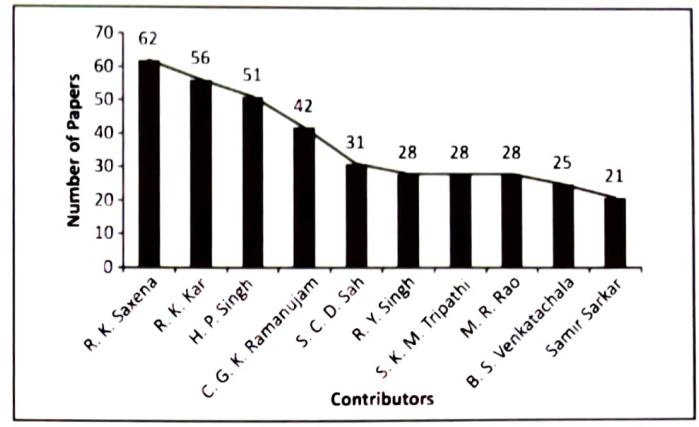
Decade-wise publications: A comparative picture of decade-wise publications is presented in Text-figure 11 to depict trend in growth of number of publications during last 75 years. The first two decades together (1941-1960) witnessed publication of only 14 papers, mainly devoted to description of palynofossils from Tertiary sediments developed in Assam-Meghalaya, Rajasthan, Madhya Pradesh, Kerala, etc. The first attempt to utilize palynofossils in biostratigraphy of Early Tertiary sediments of north-east India was made by Biswas (1962) and Baksi (1962). This paved the way for many more such studies in other areas in future. It is observed that during 1971 to 2000, the number of publications saw their zenith but in the 21st century, it experienced vertical decline from 150 (during 1991-2000) to 57 (during 2001-2010). This number is expected to fall further during the current decade (2011 to 2020). Possibly, the main reason for the fall in number of publications may be decreasing number of active Tertiary palynologists.

Top 10 contributors: The top ten contributors to the Indian Tertiary palynology, in terms of number of published papers, are depicted in Text-figure 12.

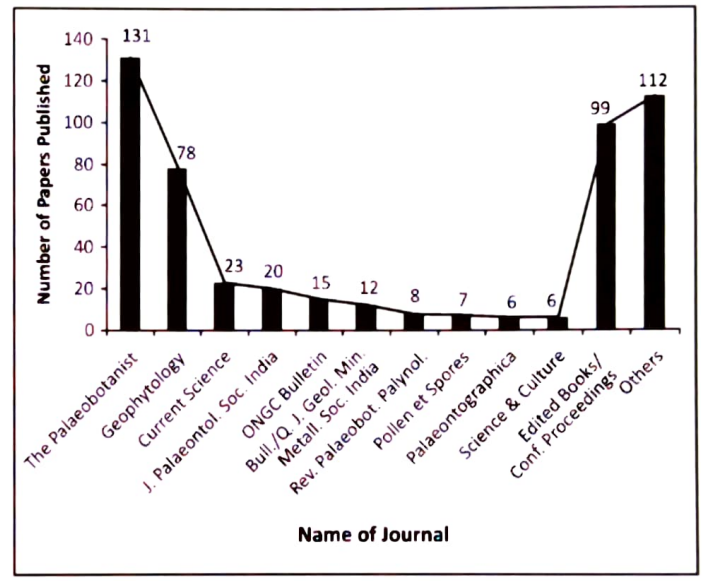
Journals with number of papers published therein: An effort has been made to find out major journals catering to papers on Indian Tertiary palynology. It has been noticed that The Palaeobotanist leads with 131 papers followed by 78 papers in Geophytology. Other journals that published papers on Tertiary palynology (with number of papers in parentheses) are Current Science (23), Journal of the Palaeontological Society of India (20), ONGC Bulletin (15), Bulletin/Quarterly Journal of the Geological, Mining and Metallurgical Society of India (12), Review of Palaeobotany and Palynology (8), Pollen et Spores (7), Palaeontographica (6), etc. (Text-figure 13).

Papers dealing with various subjects: An effort has also been made to analyze publications, subject-wise, e.g. palynostratigraphy, depositional environment, palaeoecology/palaeogeography morphology/ nomenclature, review/general papers, etc. (Text-figure 14).

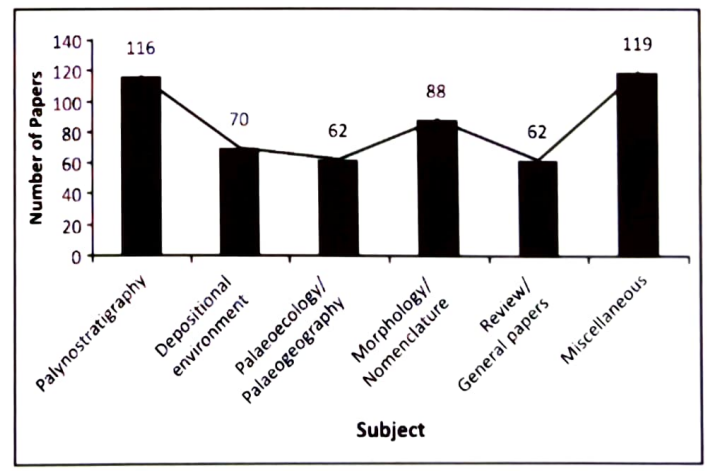
Contributions by Institutions: It is noted that among the institutions, the BSIP has been the major



Text-figure 12. Top ten contributors.

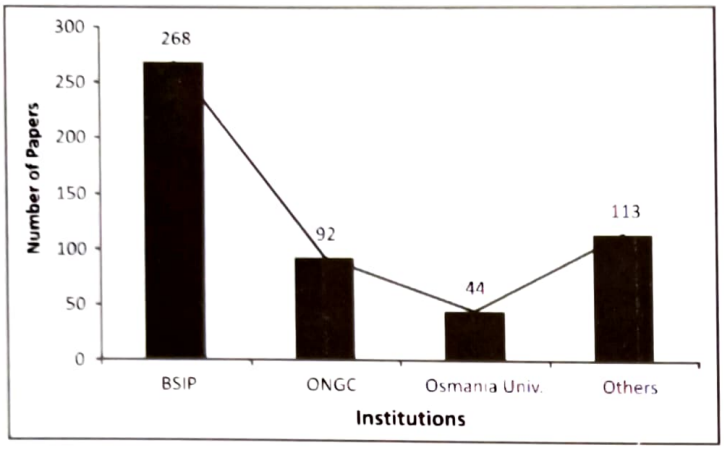


Text-figure 13. Journals with number of papers published therein.

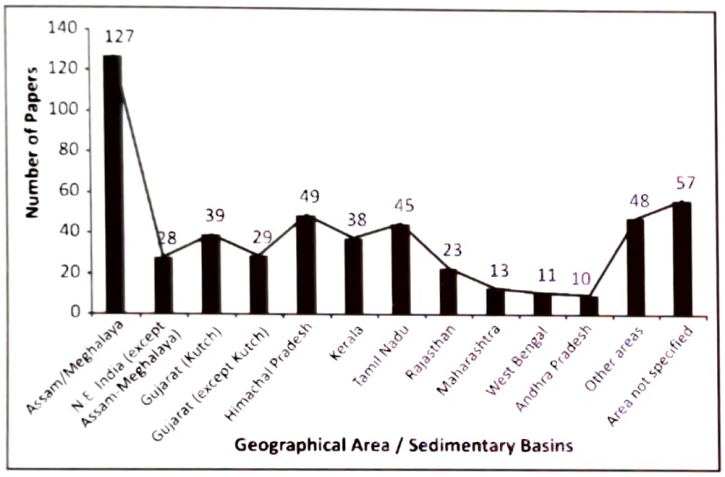


Text-figure 14. Number of papers dealing with various subjects.

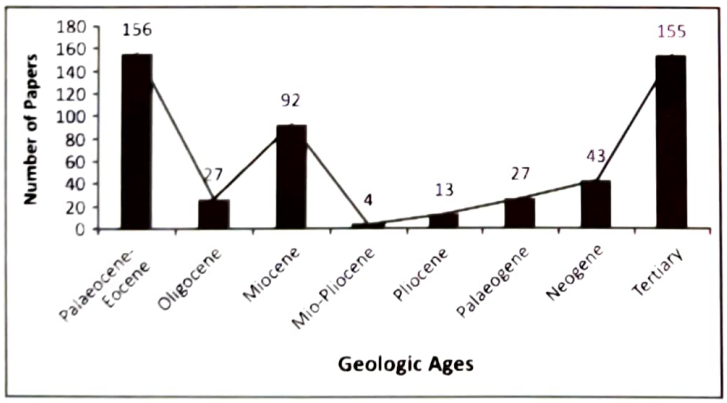
contributor followed by ONGC, Osmania University, Hyderabad and others (including GSI, WIHG, and various universities and institutions). Contributions made by these institutions were also analyzed (Text-figure 15).



Text-figure 15. Contribution by Institutions.



Text-figure 16. Number of papers dealing with various geographical areas/ sedimentary basins.



Text-figure 17. Number of papers dealing with sediments of various geologic ages.

Geographical areas/ sedimentary basins: Altogether, 517 papers have so far been published. Of these, maximum are from Assam-Meghalaya (127) followed by Gujarat (68), Himachal Pradesh (49), Tamil Nadu (45), Kerala (38), Rajasthan (23), etc. (Text-figure 16).

Geologic age: Geologic age-wise, maximum papers are published on Palaeocene-Eocene (149) followed by Miocene (88), Oligocene (24) and Pliocene (11). A good number of papers do not provide precise geologic age and are categorized as Palaeogene (24), Neogene (40) and Tertiary (99) (Text-figure 17).

GAPS IN OUR KNOWLEDGE

In spite of a large number of papers published so far on Indian Tertiary palynology, there are gaps to be filled. An effort has been made to identify such gaps and suggestions have been given for future studies.

1. While the palynostratigraphy of the Palaeocene-Early Eocene sediments of shelf facies in Meghalaya and Assam has been studied in detail, the same of their geosynclinal counterpart (Disang Group) widely developed in Meghalaya, Assam, Nagaland, Manipur and Mizoram, has largely remained uninvestigated.
2. The Eocene sediments, represented by Rengging and Yinkiong formations in Arunachal Pradesh, need be palynologically investigated to know whether or not part of this sequence pertains to Palaeocene?
3. The biostratigraphic zones of the Matanomadh Formation (Palaeocene) of Kutch Basin should be traced laterally in the basin in order to strengthen their potential for inter-regional correlation.
4. More palynological studies are required to be taken up on Kakara Series, to establish whether this is older or contemporaneous to the lower part of the Subathu Formation.
5. Pondicherry Formation (probably Palaeocene) of Tamil Nadu needs to be investigated. The subsurface Palaeocene sequence of the Cauvery Basin (Venkatachala and Rawat, 1972) may serve as a reference for future studies in this area.
6. K-T Boundary needs to be demarcated in Meghalaya, Himachal Pradesh and Cauvery Basin.
7. A precise and detailed palynostratigraphic investigation of the subsurface sediments of Bengal Basin is required to supplement the earlier information (Deb 1970, Baksi 1972). The biozones recognized in this basin are to be formally defined

and their lateral persistence is to be traced within the basin and also in the adjacent basins in north-eastern India.

8. Lateral continuity of existing biozones within the Surma sediments (Saxena et al. 1987) is to be tested by studying various Surma Group sections in N.E. India and comparing their palynofloras with that recorded earlier.
9. Palynodata from post-Surma sediments, i.e. Tipam Sandstone, Girujan Clay, Dupitila/ Namsang, Dihing/ Dhekiajuli, are meagre and scanty which preclude their utilization for zonation and correlation of these sediments and demarcation of various levels therein.
10. The palynological studies on the Neogene sediments of Tripura, Manipur, Mizoram, Nagaland and Arunachal Pradesh are scanty and require to be supplemented by more data.
11. Kutch Basin in Gujarat has good exposures of Neogene sediments but their palynostratigraphic study is only at a preliminary stage. More efforts are needed to strengthen reliability of the existing palynozones therein. Palynodata base is needed to be established from the Chhasra and Sandhan formations.
12. Lateral continuity of various palynozones in Siwalik Group is to be established by working out various Siwalik sections from Jammu to Arunachal Pradesh and comparing their palynofloral contents.
13. The palynological study on the accessible Neogene stratigraphic sections of Andaman and Nicobar Islands must be attempted.

SUGGESTIONS FOR FUTURE STUDIES

1. Palynological samples must be collected from measured stratigraphic sections. Data obtained from such sections only can be relied for biostratigraphic zonation, correlation and dating of sediments.
2. Palynodata should be tagged with data obtained from other disciplines, so as to strengthen and support our results and conclusions.
3. Efforts should be made to standardize morphotaxonomy and to trace the affinity of fossil spore-pollen taxa with modern plants.
4. Recycled palynofossils, which are helpful in locating source area/ formation and in interpreting palaeogeography, must be recognized as their non-recognition may lead to erroneous conclusions.
5. Correlation of existing biozones must be extended laterally for regional and inter-regional correlation.
6. Subsurface samples usually represent uninterrupted stratigraphic sections. Palynological studies on such sections should be intensified to evaluate subsurface data vis-à-vis that from surface sections.
7. Every palynological study starts with field work and collection of samples. Therefore, a sound knowledge of basic principles of field geology and clear concept of various types of sedimentary rocks and stratigraphic units is essential for precise inferences.
8. A sound knowledge of various rules and regulations laid down in the "International Code of Nomenclature for algae, fungi and plants (McNeill et al. 2012) is indispensable for bringing stability and discipline in palynological studies.

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