

# *Monocolpopollenites* Pflug & Thomson (monosulcate arecaceous pollen) from India

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## ABSTRACT

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The present paper incorporates Indian records of *Monocolpopollenites* Pflug & Thomson. *Palmaepollenites* Potonié and *Palmaepites* Biswas are considered here nomenclatural (homotypic) and taxonomic (heterotypic) junior synonyms respectively of *Monocolpopollenites*. The diagnosis of *Monocolpopollenites* has been emended to accommodate monosulcate, psilate (or more or less psilate), faintly punctate, granulate, scabrate or baculate pollen. Altogether, 23 species of this genus have been recognized from India. Of these, eighteen new combinations and one new species name are here proposed. These are: *Monocolpopollenites andamanicus* (Mathur & Mathur) comb. nov., *Monocolpopollenites baculatus* (Venkatachala & Rawat) comb. nov., *Monocolpopollenites cauveriensis* (Venkatachala & Rawat) comb. nov., *Monocolpopollenites cymbatus* (Rawat et al.) comb. nov., *Monocolpopollenites elongatus* (Kulkarni et al.) comb. nov., *Monocolpopollenites eocenicus* (Biswas) comb. nov., *Monocolpopollenites granulatus* (Singh & Tewari) comb. nov., *Monocolpopollenites indicus* (Ramanujam) comb. nov., *Monocolpopollenites kariii* (Saxena) comb. nov., *Monocolpopollenites keralensis* (Rao & Ramanujam) comb. nov., *Monocolpopollenites longicolpus* (Mathur & Mathur) comb. nov., *Monocolpopollenites magnus* (Sah & Kar) comb. nov., *Monocolpopollenites medicolpus* (Mathur & Mathur) comb. nov., *Monocolpopollenites neyvelii* (Ramanujam) comb. nov., *Monocolpopollenites ovatus* (Sah & Kar) comb. nov., *Monocolpopollenites plicatus* (Sah & Kar) comb. nov., *Monocolpopollenites ratnagiriensis* (Kulkarni et al.) comb. nov., *Monocolpopollenites samantiae* nom. nov., *Monocolpopollenites slimslitii* (Baksi) comb. nov.,

**Key-words:** *Monocolpopollenites*, *Palmaepollenites*, Monosulcate pollen, Arecaceae, Late Cretaceous-Tertiary, India.

## INTRODUCTION

The genus *Monocolpopollenites* Pflug & Thomson in Thomson & Pflug 1953, representing monosulcate fossil pollen of arecaceous affinity, constitutes an important element of the Indian Late Cretaceous-Tertiary palynoassemblages. However, several pollen species, assignable to this genus, are described under *Palmaepollenites* Potonié ex Potonié 1958 and *Palmaepites* Biswas 1962. These genera are considered here as junior synonyms of *Monocolpopollenites*. The diagnosis of *Monocolpopollenites* has been emended several times by various palynologists and therefore monosulcate pollen having widely diverse characters have been placed under it. Taxonomic and nomenclatural status of these genera is discussed ahead.

## MONOCOLPOPOLLENITES AND ITS SYNONYMS

*Monocolpopollenites* Pflug & Thomson in Thomson & Pflug 1953 [Type species: *Monocolpopollenites tranquillus* (Potonié 1934) Jansonius & Hills 1976 (Basionym: *Pollenites tranquillus* Potonié 1934)]: Pflug and Thomson in Thomson and Pflug (1953, p. 62) proposed *Monocolpopollenites* with the following diagnosis: Pollen grains with only one plane of symmetry. Monocolpate. Colpus in the plain of symmetry, i.e. located on the line bisecting the proximal face, but asymmetric with regard to the equator. Overall shape not bean-shaped. Colpus commonly with marginal folds are thickenings.



***Palmaepollenites Potonié 1951 ex Potonié 1958*** [Type species: *Palmaepollenites tranquillus* (Potonié 1934) Potonié 1958 (Basionym: *Pollenites tranquillus* Potonié 1934)]: Outline approx. egg-shaped, asymmetrical, indistinctly polygonal; outline approx. smooth; colpus usually not reaching the outline, narrow, barely accompanied by folds, at the ends widening in club shaped or circular manner; infragranulation more or less distinct.

***Palmaepites Biswas 1962*** (Type species: *Palmaepites eocenicus* Biswas 1962), Monotypic, Combined description: Equatorial compression; exine smooth and rather thin; grain measurements 36x24 microns; sulcus nearly as long as the long diameter of the grain, measuring 28x8 microns.

The above account makes it clear that *Palmaepollenites* Potonié 1951 ex Potonié 1958 is a nomenclatural (homotypic) junior synonym of *Monocolpopollenites* Pflug & Thomson in Thomson & Pflug 1953, because both the genera have same type species. *Palmaepites* Biswas 1962 is identical to *Monocolpopollenites* in all essential characters and cannot be distinguished from the latter. It is, therefore, considered here a taxonomic (heterotypic) junior synonym of *Monocolpopollenites* (ICBN: Article 14.4, McNeill et al. 2006).

## INDIAN RECORDS OF MONOCOLPOPOLLENITES

**Genus: *Monocolpopollenites* Pflug & Thomson in Thomson & Pflug 1953 emend.**

**Type species:** *Monocolpopollenites tranquillus* (Potonié 1934) Jansonius & Hills 1976

**Emended diagnosis:** Pollen grains oval-elliptical in shape. Small to medium sized. Monosulcate, sulcus as long as the longer axis or may be shorter, may be associated with marginal folds or thickenings. Exine generally thin, psilate (or more or less psilate), may be faintly punctate, granulate, scabrate or baculate.

**Remarks:** Potonié (1951) informally combined the type species as follows: “*Palmae*” (*Pollenites tranquillus*) (p. 137), *Palmae-pollenites tranquillus* (p. 137), *Sabaloipoll. tranquillus* (p. 138), *Palmae-poll. tranquillus* (p. 140), and *Palmaepoll.*

*tranquillus* (p. 149). Thomson and Pflug (1953) considered *Sabaloidites* as a synonym of *Monocolpopollenites*. Potonié (1958, p. 97) considered *Monocolpopollenites* as a junior synonym of *Palmaepollenites*. However, Potonié (1966, p. 159) recognized the seniority of *Monocolpopollenites*. Leschik (1956) proposed an emended diagnosis with the aim to include only smooth forms under *Monocolpopollenites*, and assign the striate species to a new genus *Decussatisporites*. Nichols et al. (1973) proposed the following emended diagnosis: Monocolpate pollen, amb oval. Colpus with flared are rounded ends, with or without margo. Exine psilate, scabrate, or reticulate, but not granulate or verrucate. Size variable in different species, ca. 20-50  $\mu\text{m}$ . The emended diagnosis, here proposed, aims to accommodate monosulcate pollen having psilate (or more or less psilate) and faintly punctate, granulate, scabrate or baculate exine.

***Monocolpopollenites andamanicus* (Mathur & Mathur 1980) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites andamanicus* Mathur & Mathur, Geoscience Jl. 1(2): 57, plate 1, figure 10. 1980.

**Original description** (Mathur & Mathur 1980, p. 57): Pollen grains monocolpate, oval-elliptical in shape with more or less narrow lateral ends, 30-35 x 15-17  $\mu\text{m}$  in size; colpi almost extending from one end to the other end, lips thickened, 2-3  $\mu\text{m}$  broad. Exine less than 1  $\mu\text{m}$  thick, scabrate.

**Indian records:** Mathur and Mathur 1980: 57, plate 1, figure 10, Upper Baratang Formation (Early Oligocene), Middle Andaman, Andaman and Nicobar Islands.

***Monocolpopollenites baculatus* (Venkatachala & Rawat 1972) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites baculatus* Venkatachala & Rawat, in Ghosh A. K. et al. (Editors) - Proceedings of the Seminar on Paleopalynology and Indian Stratigraphy, Calcutta, 1971, Botany Department, Calcutta University: 297, plate 2, figure 5. 1972.

**Original description** (Venkatachala & Rawat 1972, p. 297): Pollen grain oval with rounded lateral



ends; 29.7 x 19.8  $\mu\text{m}$ ; monocolpate, colpus distinct, narrow in the middle and broader at the ends, funnel-shaped, running along the whole length of the pollen and reaching up to the margins. Exine about 1.3  $\mu\text{m}$  thick, tectate, sexine thicker than nexine, baculate, bacula fine.

**Indian records:** Venkatachala and Rawat 1972: 297, plate 2, figure 5, Palaeocene-Eocene, Cauvery Basin, Tamil Nadu; Venkatachala 1973: 146, plate 1, figure 2, Neyveli lignite (Eocene), South Arcot District, Tamil Nadu.

*Monocolpopollenites cauveriensis*  
(Venkatachala & Rawat 1972) Saxena, comb.  
nov.

**Basionym:** *Palmaepollenites cauveriensis* Venkatachala & Rawat, in Ghosh A. K. et al. (Editors) - Proceedings of the Seminar on Paleopalynology and Indian Stratigraphy, Calcutta, 1971, Botany Department, Calcutta University: 296-297, plate 2, figure 1. 1972.

**Original description** (Venkatachala & Rawat, p. 296-297): Pollen grain oval with rounded lateral ends, 39.6 x 23.1  $\mu\text{m}$ , monocolpate; colpus broad,  $\pm$  extending along the length of the grain,  $\pm$  reaching up to the margin. Exine about 2.6  $\mu\text{m}$  thick, psilate, sexine thicker than nexine.

**Indian records:** Venkatachala and Rawat 1972: 296-297, plate 2, figure 1, Palaeocene-Eocene, Cauvery Basin, Tamil Nadu; Ramanujam and Rao 1977: 162, Warkalli Beds (Early-Middle Miocene), Kerala.

*Monocolpopollenites communis* (Sah & Dutta  
1966) Kumar & Takahashi 1991

**Synonym:** *Palmaepollenites communis* Sah & Dutta, Palaeobotanist 15(1-2): 77, plate 1, figure 10. 1966.

**Original description** (Sah & Dutta 1966, p. 77): Size range 30 x 15 to 34 x 20  $\mu\text{m}$ ; bilateral, amb ellipsoidal. Monosulcate, sulcus straight, usually extending from pole to pole, sometimes slightly shorter; lips slightly raised. Exine thin, less than 1  $\mu\text{m}$ ; generally smooth, but sometimes appears to be faintly sculptured.

**Indian records:** Sah and Dutta 1966: 77, plate

1, figure 10, Cherra Formation (Palaeocene), Shillong Plateau, Meghalaya; Sah and Dutta 1968: 188, plate 1, figure 19, Palaeocene, Assam; Dutta and Sah 1970: 31, plate 5, figures 7-9, Early Eocene, Meghalaya; Singh et al. 1976: 50, Palaeocene, Nongwal Bibra, Garo Hills, Meghalaya; Singh 1977: 196, Tura Formation (Palaeocene), Nongwal Bibra, Garo Hills, Meghalaya; Sah et al. 1980: 642, plate 1, figure 13, Girujan Clay (Miocene), Nahorkatiya Well no. 1, Assam; Nandi 1981: 30, plate 2, figure 32, Neogene, Moran and Nahorkatiya Wells, Assam; Mehrotra 1983: 11-12, plate 4, figure 17, Mikir Formation (Palaeocene-Early Eocene), Garampani, North Cachar Hills, Assam; Nandi and Sharma 1984: 568, plate 2, figure 12, Boldamgiri Formation (Early Miocene), Tura-Damalgiri Road Section, Garo Hills, Meghalaya; Tripathi and Singh 1985: 177, plate 3, figure 32, Therria Formation (Palaeocene), Jowai-Sonapur Road Section, Jaintia Hills, Meghalaya; Singh et al. 1985: 32, Barail Group (Oligocene), Assam and Meghalaya; Prasad and Dey 1986: 72, plate 1, figure 23, Eocene, nala sections around Yinkiong and Dalbuing, East Siang District, Arunachal Pradesh; Singh and Dogra 1988: 59, Palana Formation (Palaeocene), Bikaner District, Rajasthan; Kumar and Takahashi 1991: 553-554, plate 15, figure 18, Renji Formation (Late Oligocene), Silchar-Haflong Road Section, Assam; Kumar 1994: 69, 82, plate 37, figure 12, Bhuban and Bokabil formations (Miocene), Silchar-Haflong Road Section, Assam; Mandal 1990: 325, Lakadong Sandstone Member, Sylhet Limestone Formation (Palaeocene), Thanjinath, Khasi Hills, Meghalaya; Handique et al. 1992: 218, 219, Kopili Formation and Barail Group (Eocene-Oligocene), Moran Oilfield, Upper Assam; Banerjee and Nandi 1994: 219, plate 1, figure 11, Middle Bhuban Formation (Early-Middle Miocene), near Kolasib, Aizawl District, Mizoram; Kumar 1994: 31, plate 15, figure 12, plate 16, figure 8, Jenam Formation (Middle Oligocene), Silchar-Haflong Road Section, Assam; Bera and Banerjee 1995: 150, Bengal lignite (Middle-Late Eocene), Panagarh-Domra Sector, Burdwan District, West Bengal; Saxena et al. 1996: 21, Tura Formation (Palaeocene), Nongwal Bibra area, East Garo Hills District, Meghalaya; Mitra et al. 2000: 126, plate 1, figure 19, Siwalik Group (Neogene),



Darjeeling Foothills, Eastern Himalaya.

***Monocolpopollenites cymbatus* (Rawat et al. 1977) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites cymbatus* Rawat et al., in Venkatachala B. S. & Sastri V. V. (Editors) - Proceedings of the 4th Colloquium on Indian Micropaleontology and Stratigraphy, Dehradun, 1974-75, Institute of Petroleum Exploration, Oil and Natural Gas Commission, Dehradun: 180-181, plate 1, figures 10, 18. 1977.

**Original description** (Rawat et al. 1977, p. 180-181): Pollen elongated; oval with slightly rounded lateral ends; monocolpate, 25 x 55-68  $\mu\text{m}$ . Colpus distinct, broad, running along the length of the pollen,  $\pm$  extending up to lateral ends. Exine up to 2  $\mu\text{m}$  thick, sexine as thick as nexine, granulate; grana closely placed, up to 0.5  $\mu\text{m}$  in diameter.

**Indian records:** Rawat et al. 1977: 180-181, plate 1, figures 10, 18, Kadi Formation (Early Eocene), Cambay Basin, Gujarat.

***Monocolpopollenites elongatus* (Kulkarni et al. 1985) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites elongatus* Kulkarni et al., in Varghese T. M. (Editor) - Recent Advances in Pollen Research, Allied Publishers Private Limited: 297-298, plate 1, figure 5. 1985.

**Original description** (Kulkarni et al. 1985, p. 297-298): Pollen grains peroblate, heteropolar, biconvex laterally, 16.6 x 50.0  $\mu\text{m}$ ; monosulcate, sulcus slightly opened, longisulcate, crassimarginate; exine 1.6  $\mu\text{m}$  thick, psilate.

**Indian records:** Kulkarni et al. 1985: 297-298, plate 1, figure 5, Ratnagiri Beds (Miocene), well 10 km south of Ratnagiri on Ratnagiri-Pawas Road, Ratnagiri District, Maharashtra.

***Monocolpopollenites eocenicus* (Biswas 1962) Saxena, comb. nov.**

**Basionym:** *Palmaepites eocenicus* Biswas, Bull. Geol. Min. Metall. Soc. India 25: 40, plate 6, figure 26. 1962.

**Synonym:** *Palmaepollenites eocenicus* (Biswas) Sah & Dutta, Palaeobotanist 15(1-2): 77, plate 1, figure 7. 1966.

**Original description** (Biswas 1962, p. 40): Equatorial compression; exine smooth and rather thin; grain measurements 36 x 24  $\mu\text{m}$ ; sulcus nearly as long as the long diameter of the grain, measuring 28 x 8  $\mu\text{m}$ .

**Restated description** (Sah & Dutta 1966, p. 77): Size range 35 x 24 to 44 x 40  $\mu\text{m}$ ; amb oval to ellipsoidal. Monosulcate, sulcus long, but not completely reaching the equator, lips thin and usually gaping. Exine up to 2  $\mu\text{m}$  thick, smooth, but at places appears to be faintly sculptured.

**Indian records:** Biswas 1962: 40, plate 6, figure 26, Tura Formation (Early Eocene), Meghalaya; Ghosh 1969: 131, plate 1, figure 27, Tura Formation (Early Eocene), Daranggiri and Rongrenggiri, Garo Hills, Meghalaya; Sah and Dutta 1966: 77, plate 1, figure 7, Cherra Formation (Palaeocene), Shillong Plateau, Meghalaya; Sah and Dutta 1968: 188, plate 1, figures 16-17, Palaeocene-Oligocene, Meghalaya; Singh 1977: 196, Tura Formation (Palaeocene), Nongwal Bibra, Garo Hills, Meghalaya; Rao and Ramanujam 1978: 412, plate 3, figure 38, Quilon Beds (Miocene), Padappakkara, Kerala; Koshal 1980: 687, Eocene, Dabka, Gujarat; Sah et al. 1980: 642, plate 2, figure 24, Girujan Clay (Miocene), Nahorkatiya Well no. 1, Assam; Nandi 1980: 729, Lower Siwalik (Miocene), Punjab, Himachal Pradesh and Uttar Pradesh; Nandi 1981: 30, plate 2, figure 31, Neogene, Moran and Nahorkatiya Wells, Assam; Mehrotra 1983: 12, plate 4, figure 14, Mikir Formation (Palaeocene-Early Eocene), Garampani, North Cachar Hills, Assam; Sarma et al. 1984: 202-203, plate 1, figure 5, Neyveli Lignite (Miocene), Neyveli, South Arcot District, Tamil Nadu; Nandi and Sharma 1984: 568, plate 2, figure 11, Boldamgiri Formation (Early Miocene), Tura-Damalgiri Road Section, Garo Hills, Meghalaya; Phadtare and Kulkarni 1984: 524, plate 1, figure 6, Ratnagiri Beds (Miocene), well at Golap on Ratnagiri-Pawas Road, Ratnagiri District, Maharashtra; Koshal and Uniyal 1984: 238, 240, plate 1, figure 28, plate 2, figure 5, Palaeocene-Early Eocene, North Cambay Basin, Gujarat; Dogra et al. 1985: 69, plate 2, figure 36, Dharmasala Beds (Oligo-Miocene), Dharmasala, Kangra District, Himachal Pradesh; Kulkarni et al. 1985: 296-297, plate 1, figure 2, Ratnagiri Beds



(Miocene), well 10 km south of Ratnagiri on Ratnagiri-Pawas Road, Ratnagiri District, Maharashtra; Singh et al. 1985: 32, Barail Group (Oligocene), Assam and Meghalaya; Prasad and Dey 1986: 69, Eocene, nala sections around Yinkiong and Dalbuing, East Siang District, Arunachal Pradesh; Koshal and Uniyal 1986: 216, plate 3, figures 77-78, 83, Palaeocene-Oligocene, Cambay Basin, Gujarat; Varma et al. 1986: 42, plate 1, figure 15, Miocene, Tonakkal clay mine, Trivandrum District, Kerala; Siddhanta 1986: 64, plate 2, figures 9-10, Neyveli Formation (Palaeocene-Eocene), Neyveli, South Arcot District, Tamil Nadu; Kapoor and Singh 1987: 18, Subathu Formation (Palaeocene), Kalka-Kasauli Road Section, Solan District, Himachal Pradesh; Varma 1987: 167, plate 1, figure 14, Miocene, Tonakkal clay mine, Trivandrum District, Kerala; Singh and Dogra 1988: 54, 59, Palana Formation (Palaeocene), Bikaner District, Rajasthan and Cherra Formation (Palaeocene), Cherrapunji, Khasi Hills District, Meghalaya; Kapoor et al. 1988: 108, plate 2, figures 27, 32, Kasauli Formation (Early Miocene), Kasauli, Solan District, Himachal Pradesh; Rao 1990: 246, plate 1, figure 6, Eocene-Early Miocene, Arthungal Borehole, Alleppey District, Kerala; Ramanujam et al. 1991: 53, plate 1, figure 10, Early Miocene, Pattanakad Borewell, Alleppey District, Kerala; Ramanujam et al. 1991: 3, plate 2, figure 1, Neogene, Mynagapalli Borewell, Quilon District, Kerala; Handique et al. 1992: 218, Kopili Formation (Late Eocene), Moran Oilfield, Upper Assam; Ramanujam et al. 1992: 21, figure 2D, Mayyanad and Quilon formations (Early Miocene), Kalaikode Borewell, Quilon District, Kerala; Rao et al. 1993: 81, Early Miocene, Thakkazhi Borewell, Alleppey District, Kerala; Shanmukhappa and Koshal 1993: 200, 201, Ankleshwar Formation (Middle Eocene), Gandhar area, Broach Depression, Cambay Basin, Gujarat; Kumar 1994: 31, plate 15, figures 7, 11, Jenam Formation (Middle Oligocene), Silchar-Haflong Road Section, Assam; Rao et al. 1995: 374, figure 15, Early Miocene, Borewell at Kulasekharamangalam, Kottayam District, Kerala; Tripathi 1995: 47, Palaeocene-Eocene, subsurface sediments near Kapurdi, Barmer District, Rajasthan; Kapoor et al. 1997: 33, figure 2e, Subathu Formation (Palaeocene-Eocene), Kalka-Kasauli Road, Solan

District, Himachal Pradesh; Samant and Phadtare 1997: 38, plate 7, figure 14, Tarkeshwar Formation (Early Eocene), Rajpardi, Cambay Basin, Gujarat; Ramanujam et al. 1998: 55, figure 3, Miocene, Borewell NSP-1 and NSP-2 near Narsapur, West Godavari District, Andhra Pradesh; Ramanujam et al. 1999: 35, plate 1, figures 5-7, Miocene, South Arcot and Thanjavur districts, Tamil Nadu; Pundeer and Mehrotra 2000: 141, Basal Sandstone (Thanetian-Ypresian), Upper Assam Shelf; Samant 2000: 114, plate 4, figure 6, Kharsalia Clay Formation (Early Eocene), near Bhavnagar, Cambay Basin, Gujarat; Kumar et al. 2001: 244, Barail Group (Oligocene), Tinali Well-7, Upper Assam; Samant and Tapaswi 2001: 128, Surat lignite, Cambay Shale Formation (Early Eocene), Tarkeshwar, Surat District and Valia, Bharuch District, Gujarat; Gupta et al. 2003: 211, plate 1, figure 3, Palaeocene-Eocene, Ganga Basin; Tripathi et al. 2003: 91, Akli Formation (Late Palaeocene), Barmer Basin, Rajasthan; Tripathi et al. 2009: 152, Akli Formation (Early Palaeogene, Barmer Basin, Rajasthan).

***Monocolpopollenites granulatus* (Singh & Tewari 1978) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites granulatus* Singh & Tewari, Recent Researches in Geology 5: 497, plate 3, figures 43, 48. 1978.

**Original description** (Singh & Tewari 1978, p. 497): Pollen grains elliptical, 30-40  $\mu\text{m}$ . Monosulcate, sulcus extending from pole to pole, sometimes much wider at the ends. Exine moderately thick, granulose.

**Indian records:** Singh and Tewari 1978: 497, plate 3, figures 43, 48, Gumaghat and Mahadeo formations (Late Cretaceous), Meghalaya.

***Monocolpopollenites indicus* (Ramanujam 1966) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites indicus* Ramanujam, Pollen Spores 8(1): 157, plate 1, figures 13-14. 1966.

**Original description** (Ramanujam 1966, p. 157): Pollen bilateral, oval to elliptical, poles tapering, monosulcate, 38 x 22  $\mu\text{m}$ . Sulcus very narrow, long, ends blunt, margin tenuimarginate. Exine 1.5  $\mu\text{m}$  thick, surface smooth.



**Indian records:** Ramanujam 1966: 157, plate 1, figures 13-14, Cuddalore Series (Miocene-Pliocene), Neyveli, South Arcot District, Tamil Nadu; Kumar 1996: 112, plate 2, figure 6, Tarkeshwar Formation (Early Eocene), Rajpardi, Bharuch District, Gujarat.

***Monocolpopollenites karii* (Saxena 1993)**

**Saxena, comb. nov.**

**Basionym:** *Palmaepollenites karii* Saxena 1993: 195 ( $\equiv$  *Palmaepollenites longicolpus* Kar & Singh, non Mathur & Mathur 1969): 114, plate 10, figures 5, 26. 1986.

**Original description** (Kar & Singh 1986, p. 114): Pollen grains monocolpate, oval to ellipsoidal, 37-42 x 22-24  $\mu\text{m}$ . Colpus thin, uniform, almost extending one end to other. Exine about 1  $\mu\text{m}$  thick, psilate.

**Indian records:** Kar and Singh 1986: 114, plate 10, figures 5, 26, Jadukata and Mahadek formations (Late Cretaceous), Ranikor-Barsaura Road Section, Nongnah, Meghalaya.

***Monocolpopollenites keralensis* (Rao & Ramanujam 1978) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites keralensis* Rao & Ramanujam, *Palaeobotanist* 25: 411, plate 3, figure 36. 1978.

**Original description** (Rao & Ramanujam 1978, p. 411): Pollen grains heteropolar, amb roughly rhombic, narrow towards one and broader towards other end, 37.5-42 x 26-28  $\mu\text{m}$ , monosulcate, sulcus long but not reaching equatorial margin, club-shaped, narrow at one end and gradually widening at other end, margins thickened at mid region, ends blunt. Exine 1.5  $\mu\text{m}$  thick, sexine as thick as nexine, surface smooth.

**Indian records:** Rao and Ramanujam 1978: 411, plate 3, figure 36, Quilon Beds (Miocene), Padappakkara, Kerala; Sarma et al. 1984: 202, plate 1, figure 4, Neyveli lignite (Miocene), Neyveli, South Arcot District, Tamil Nadu; Rao 1990: 246, plate 1, figure 15, Eocene-Early Miocene, Arthungal Borehole, Alleppey District, Kerala; Ramanujam et al. 1992: 21, figure 2E, Mayyanad and Quilon formations (Early Miocene), Kalaikode Borewell, Quilon District, Kerala; Rao et al. 1993: 81, plate 1, figures 10-11, Early Miocene, Thakkazhi Borewell, Alleppey District,

Kerala; Bera and Banerjee 1995: 150, Bengal lignite (Middle-Late Eocene), Panagarh-Domra Sector, Burdwan District, West Bengal; Rao et al. 1995: 374, Early Miocene, Borewell at Kulasekharamangalam, Kottayam District, Kerala; Rao 1995: 327, plate 4, figure 13, Eocene-Early Miocene, Kalarakod and Nirkunnam Boreholes, Alleppey District, Kerala; Rao and Nair 1998: 52, Miocene, Kannanellur-Kundra Road area, Quilon District, Kerala; Mitra et al. 2000: 126, plate 1, figure 17, Siwalik Group (Neogene), Darjeeling Foothills, Eastern Himalaya.

***Monocolpopollenites kutchensis* (Venkatachala & Kar 1969) Saxena & Trivedi 2009**

**Synonym:** *Palmaepollenites kutchensis* Venkatachala & Kar, *Palaeobotanist* 17(2): 159, plate 1, figures 9-10. 1969.

**Original description** (Venkatachala & Kar 1969, p. 159): Pollen grains mostly oval with equally broad rounded to pointed lateral ends. 25-30 x 10-15  $\mu\text{m}$ . Monocolpate, colpus distinct, broad, generally broader at middle region and tapering at ends, boat shaped, not reaching up to margins. Exine up to 2  $\mu\text{m}$  thick,  $\pm$  laevigate or slightly granulose.

**Indian records:** Venkatachala and Kar 1969: 159, plate 1, figures 9-10, Naredi Formation (Early Eocene), Matanomadh, Kutch District, Gujarat; Venkatachala and Rawat 1972: 296, plate 1, figures 21-22, Palaeocene-Eocene, Cauvery Basin, Tamil Nadu; Rawat et al. 1977: 186, Kadi Formation (Early Eocene), Cambay Basin, Gujarat; Ramanujam and Rao 1977: 162, Warkalli Beds (Early-Middle Miocene), Kerala; Kar 1978: 163, 167, Naredi and Harudi formations (Early-Middle Eocene), Kutch District, Gujarat; Saxena 1979: 133, plate 2, figure 15, Matanomadh Formation (Palaeocene), Matanomadh, Kutch District, Gujarat; Kar and Jain 1981: 118, plate 3, figure 59, Neogene, around Quilon and Varkala, Kerala; Kar and Saxena 1981: 106, Middle-Late Eocene, bore core no. 27 near Rataria, Kutch District, Gujarat; Venkatachala and Sharma 1984: 451, Eocene, Narsapur Well no. 1, West Godavari District, Andhra Pradesh; Kar 1985: 18, 36, 57, 111, plate 2, figure 8, plate 11, figures 1-3, Matanomadh, Naredi and Harudi formations (Palaeocene-Eocene), Matanomadh, bore



core no. 14 near Matanomadh, bore core no. 13 near Baranda, Panandhro, Akri, bore core nos. 1 and 2 near Lakhpat, bore core no. 27 near Rataria and Harudi, Kutch District, Gujarat; Raha et al. 1986a: 48, plate 1, figures 1-2, Eocene, borehole near Ambalapuzha, Alleppey District, Kerala; Raha et al. 1986b: 228, 231, plate 1, figure 9, plate 2, figures 9, 26, Mayyanad Formation (Eocene), borehole near Ambalapuzha, Alleppey District, Kerala; Prasad and Dey 1986: 69, Eocene, nala sections around Yinkiong and Dalbuing, East Siang District, Arunachal Pradesh; Ramanujam 1987: 28, plate 1, figure 12, Warkalli Beds (Miocene), Kerala; Kar 1990b: 237, Renji Formation (Late Oligocene), Silchar-Haflong Road Section, Assam; Rao 1990: 246, plate 1, figure 5, Eocene-Early Miocene, Arthungal Borehole, Alleppey District, Kerala; Kar and Bhattacharya 1992: 251, plate 2, figure 13, Early Eocene, Gujra Dam Section and Akri lignite, Kutch District and Rajpardi lignite mine, Cambay Basin, Gujarat; Mandaokar 1993: 139, plate 1, figures 4, 8, Tikak Parbat Formation (Late Oligocene), Dangri Kumari Colliery, Dibrugarh District, Assam; Shanmukhappa and Koshal 1993: 195, 201, 202, Cambay Shale and Ankleshwar formations (Early-Late Eocene), Gandhar area, Broach Depression, Cambay Basin, Gujarat; Kar et al. 1994: 186, Tertiary, subsurface sediments in Upper Assam; Misra and Kapoor 1994: 155, Subathu and Basal and Lower Dharmasala (Palaeocene-Early Eocene and Middle Eocene), Jwalamukhi-B Well, northern part of Jwalamukhi Structure, Himachal Pradesh; Bera and Banerjee 1995: 150, Bengal lignite (Middle-Late Eocene), Panagarh-Domra Sector, Burdwan District, West Bengal; Rao 1995: 327, Eocene-Early Miocene, Kalarakod and Nirkunnam Boreholes, Alleppey District, Kerala; Tripathi 1995: 47, Palaeocene-Eocene, subsurface sediments near Kapurdi, Barmer District, Rajasthan; Rao and Rajendran 1996: 66, Miocene, Cannanore District, Kerala; Mandal 1997: 99, Barail Group (Late Eocene), Mariani-Mokokchung Road, Mokokchung District, Nagaland; Samant and Phadtare 1997: 38, plate 7, figure 15, Tarkeshwar Formation (Early Eocene), Rajpardi, Cambay Basin, Gujarat; Ramanujam et al. 1998: 55, figure 9, Miocene, Borewell NSP-1 and NSP-2 near Narsapur, West Godavari

District, Andhra Pradesh; Mandaokar 1999: 241, Disang Group (Late Eocene), Tirap River Section, Tinsukia District, Assam; Ramanujam et al. 1999: 35, plate 1, figure 16, Miocene, South Arcot and Thanjavur districts, Tamil Nadu; Aswal and Singh 2000: 122, 123, Danian and Thanetian, Saripalli Well-A, Krishna-Godavari Basin, Andhra Pradesh; Mandaokar 2000a: 320, Bhuban Formation (Early Miocene), Ramrikawn near Chandmari, Aizawl District, Mizoram; Mandaokar 2000c: 38, Tikak Parbat Formation (Late Oligocene), Namchik River Section, Changlang District, Arunachal Pradesh; Mitra et al. 2000: 126, plate 1, figure 15, Siwalik Group (Neogene), Darjeeling Foothills, Eastern Himalaya; Samant 2000: 114, Kharsalia Clay Formation (Early Eocene), near Bhavnagar, Cambay Basin, Gujarat; Kar and Sharma 2001: 129, Palana Formation (Late Palaeocene-Early Eocene), Bikaner-Nagaur area, Bikaner District, Rajasthan; Kumar et al. 2001: 244, Barail Group (Oligocene), Tinali Well-7, Upper Assam; Samant and Tapaswi 2001: 128, Surat lignite, Cambay Shale Formation (Early Eocene), Tarkeshwar, Surat District and Valia, Bharuch District, Gujarat; Mandaokar 2002b: 21, Tikak Parbat Formation (Late Oligocene), Borjan Coalfield, Nagaland; Gupta et al. 2003: 211, Palaeocene-Eocene, Ganga Basin; Tripathi et al. 2003: 91, Akli Formation (Late Palaeocene), Barmer Basin, Rajasthan; Mandal and Guleria 2006: 60, Vastan Lignite (Early Eocene), Vastan Lignite Mine, Surat District, Gujarat; Mandaokar 2007: 41, Bhuban Formation (Early Miocene), Chawngte, Lawngtlai District, Mizoram; Tripathi et al. 2009: 152, Akli Formation (Early Palaeogene, Barmer Basin, Rajasthan).

***Monocolpopollenites longicolpus* (Mathur & Mathur 1969) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites longicolpus* Mathur & Mathur, Bull. Geol. Min. Metall. Soc. India 42: 6, plate 1, figure 12. 1969.

**Original description** (Mathur & Mathur 1969, p. 6): Apolar, bilaterally symmetrical, 25 µm long and 20 µm broad, ellipsoidal, monocolpate. Colpus long, broad, tapering towards the ends. Exine thin, intragranulose, brownish yellow.

**Indian records:** Mathur and Mathur 1969: 6,



plate 2, figure 12, Naera Formation (Pliocene), Baraia and Naera, Kutch District, Gujarat; Kar 1985: 161, plate 38, figure 3, Pliocene, Baraia and Naera, Kutch District, Gujarat.

***Monocolpopollenites magnus* (Sah & Kar 1970)  
Saxena, comb. nov.**

**Basionym:** *Palmaepollenites magnus* Sah & Kar, Palaeobotanist 18(2): 129, plate 1, figure 18. 1970.

**Original description** (Sah & Kar 1970, p. 129): Pollen grains oval, large in size, 130-160 x 50-70  $\mu\text{m}$ . Monocolpate, colpus extending end to end, closed, indistinct in some specimens, may be associated with fold. Exine up to 2  $\mu\text{m}$  thick, mostly laevigate, sometimes weakly granulose.

**Indian records:** Sah and Kar 1970: 129, plate 1, figure 18, Naredi Formation (Early Eocene), Kutch District, Gujarat; Kar 1978: 163, Naredi Formation (Early Eocene), Kutch District, Gujarat; Kar 1985: 57, 59, Naredi Formation (Early Eocene), bore core no. 15 near Baranda and bore core nos. 1 and 2 near Lakhpat, Kutch District, Gujarat; Kar and Bhattacharya 1992: 251, Early Eocene, Rajpardi lignite mine, Cambay Basin, Gujarat.

***Monocolpopollenites medicolpus* (Mathur & Mathur 1969) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites medicolpus* Mathur & Mathur, Bull. Geol. Min. Metall. Soc. India 42: 7, plate 2, figure 16. 1969.

**Original description** (Mathur & Mathur 1969, p. 7): Apolar, bilaterally symmetrical, 29  $\mu\text{m}$  long and 24  $\mu\text{m}$  broad, oval, monocolpate. Colpi not extending from one margin to another, narrow. Exine thin, intragranulose, brownish yellow.

**Indian records:** Mathur and Mathur 1969: 7, plate 2, figure 16, Naera Formation (Pliocene), Baraia and Naera, Kutch District, Gujarat; Kar 1985: 161, plate 38, figure 5, Pliocene, Baraia and Naera, Kutch District, Gujarat; Mandaokar 2007: 41, Bhuvan Formation (Early Miocene), Chawngte, Lawngtlai District, Mizoram.

***Monocolpopollenites nadhamunii***

**(Venkatachala & Kar 1969) Saxena & Trivedi  
2009**

**Synonym:** *Palmaepollenites nadhamunii* Venkatachala & Kar, Palaeobotanist 17(2): 159, plate 1, figures 11-12. 1969.

**Original description** (Venkatachala & Kar 1969, p. 159): Pollen grains elliptical-spindle in shape, with pointed or blunt lateral ends. 25-30 x 15-22  $\mu\text{m}$ . Monocolpate, colpus well developed, narrow, uniformly broad or somewhat broadened at one end, extending from one margin to other. Exine up to 2.5  $\mu\text{m}$  thick, laevigate, sometimes granulose.

**Indian records:** Venkatachala and Kar 1969: 159, plate 1, figures 11-12, Naredi Formation (Early Eocene), Matanomadh, Kutch District, Gujarat; Sah and Kar 1970: 129, Naredi Formation (Early Eocene), Kutch District, Gujarat; Jain et al. 1973: 153, plate 1, figure 16, Barmer Sandstone (Palaeocene), near Barmer Hill, Barmer District, Rajasthan; Sah and Kar 1974: 167, Palana lignite (Early Eocene), Palana, Bikaner District, Rajasthan; Kar 1978: 163, Naredi Formation (Early Eocene), Kutch District, Gujarat; Saxena 1979: 133, plate 2, figures 16-17, Matanomadh Formation (Palaeocene), Matanomadh, Kutch District, Gujarat; Kar and Jain 1981: 114, plate 3, figures 60-61, Neogene, around Quilon and Varkala, Kerala; Kar and Saxena 1981: 106, Middle-Late Eocene, bore core no. 27 near Rataria, Kutch District, Gujarat; Kar 1985: 18, 36-37, 57, 111, plate 2, figure 9, plate 19, figure 5, Matanomadh and Naredi formations (Palaeocene-Early Eocene, Matanomadh, bore core no. 14 near Matanomadh, bore core nos. 1 and 2 near Lakhpat and bore core no. 27 near Rataria, Kutch District, Gujarat; Siddhanta 1986: 64, plate 2, figures 11-12, Neyveli Formation (Palaeocene-Eocene), Neyveli, South Arcot District, Tamil Nadu; Kar 1990a: 176, Surma and Tipam groups (Miocene), Rokhia Borehole no. 1, Gojalia Borehole no. 1 and Baramura Borehole no. 2, Tripura; Mandal 1990: 325, Lakadong Sandstone Member, Sylhet Limestone Formation (Palaeocene), Thanjinath, Khasi Hills, Meghalaya; Kar and Bhattacharya 1992: 251, Early Eocene, Gujra Dam Section and Akri lignite, Kutch District, Gujarat; Kar et al. 1994: 186, plate 2, figure 11, Tertiary, subsurface



sediments in Upper Assam; Misra and Kapoor 1994: 153, plate 2, figure 23, Subathu and Basal Dharmshala (Palaeocene-Early Eocene), Jwalamukhi-B Well, northern part of Jwalamukhi Structure, Himachal Pradesh; Singh and Sarkar 1994: 50, plate 1, figure 18, Kasauli Formation (Early Miocene), Kasauli, Solan District, Himachal Pradesh; Tripathi 1995: 47, Palaeocene-Early Eocene, subsurface sediments near Kapurdi, Barmer District, Rajasthan; Mandaokar 1996: 41, Tikak Parbat Formation (Late Oligocene), Dilli-Jeypore Colliery, Dilli-Jeypore Coalfields, Dibrugarh District, Assam; Samant and Phadtare 1997: 38, plate 7, figures 16-17, Tarkeshwar Formation (Early Eocene), Rajpardi, Cambay Basin, Gujarat; Mandaokar 2000b: 181, plate 2, figure 17, Tikak Parbat Formation (Late Oligocene), Jeypore Colliery, Dilli-Jeypore Coalfields, Dibrugarh District, Assam; Trivedi and Saxena 2000: 275, plate 1, figure 14, Kopili Formation (Early Eocene), Umrongso-Haflong Road near Umrongso, North Cachar Hills District, Assam; Kumar et al. 2001: 244, 245, Barail, Surma and Tipam groups (Oligocene and Miocene), Tinali Well-7, Upper Assam; Samant and Tapaswi 2001: 128, Surat lignite, Cambay Shale Formation (Early Eocene), Tarkeshwar, Surat District and Valia, Bharuch District, Gujarat; Gupta et al. 2003: 211, Palaeocene-Early Eocene, Ganga Basin (Reworked); Tripathi et al. 2003: 91, Akli Formation (Late Palaeocene), Barmer Basin, Rajasthan; Tripathi et al. 2009: 152, Akli Formation (Early Palaeogene, Barmer Basin, Rajasthan.

***Monocolpopollenites neyvelii* (Ramanujam 1966) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites neyvelii* Ramanujam, Pollen Spores 8(1): 157, plate 1, figures 11-12. 1966.

**Original description** (Ramanujam 1966, p. 157): Pollen bilateral, elliptical, often sharply tapering at both poles, monosulcate, 35 x 20  $\mu\text{m}$ . Sulcus long, narrow, ends blunt, margin crassimarginate, 2.5  $\mu\text{m}$  thick. Exine 2.5  $\mu\text{m}$  thick, surface smooth.

**Indian records:** Ramanujam 1966: 157, plate 1, figures 11-12, Cuddalore Series (Miocene-Pliocene), Neyveli, South Arcot District, Tamil Nadu; Rao and Ramanujam 1975: 731, Quilon Beds (Miocene),

Kerala; Rao and Ramanujam 1978: 411-412, plate 3, figure 37, Quilon Beds (Miocene), Padappakkara, Kerala; Phadtare and Kulkarni 1980: 160, plate 2, figure 11, Ratnagiri Beds (Miocene), Ratnagiri-Pawas Road near Third Dharmshala stop 10 km south of Ratnagiri, Ratnagiri District, Maharashtra; Kar and Jain 1981: 118, plate 3, figure 58, (Neogene), around Quilon and Varkala, Kerala; Srisailam and Ramanujam 1982: 124, plate 1, figure 2, Warkalli Beds (Miocene), Cannanore District, Kerala; Phadtare and Kulkarni 1984: 524, plate 1, figure 7, Ratnagiri Beds (Miocene), well at Golap on Ratnagiri-Pawas Road, Ratnagiri District, Maharashtra; Sarma et al. 1984: 202, Neyveli lignite (Miocene), Neyveli, South Arcot District, Tamil Nadu; Kulkarni et al. 1985: 297, plate 1, figure 4, Ratnagiri Beds (Miocene), well 10 km south of Ratnagiri on Ratnagiri-Pawas Road, Ratnagiri District, Maharashtra; Dogra et al. 1985: 69, plate 2, figure 37, Dharmshala Beds (Oligo-Miocene), Dharmshala, Kangra District, Himachal Pradesh; Ramanujam et al. 1991: 53, Early Miocene, Pattanakad Borewell, Alleppey District, Kerala; Ramanujam et al. 1992: 21, Mayyanad and Quilon formations (Early Miocene), Kalaikode Borewell, Quilon District, Kerala; Hait and Banerjee 1994: 115, plate 1, figure 7, Early Miocene, near Suangpuilawn village about 20 km north-east of Aizawl, Mizoram; Bera and Banerjee 1995: 150, Bengal lignite (Middle-Late Eocene), Panagarh-Domra Sector, Burdwan District, West Bengal; Samant and Phadtare 1997: 37, plate 7, figure 18, Tarkeshwar Formation (Early Eocene), Rajpardi, Cambay Basin, Gujarat; Ramanujam et al. 1998: 55, figure 1, Miocene, Borewell NSP-1 and NSP-2 near Narsapur, West Godavari District, Andhra Pradesh; Ramanujam et al. 1999: 35, plate 1, figures 11, 15, 17, Miocene, South Arcot and Thanjavur districts, Tamil Nadu.

***Monocolpopollenites ovatus* (Sah & Kar 1970) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites ovatus* Sah & Kar, Palaeobotanist 18(2): 129, plate 1, figure 13. 1970.

**Original description** (Sah & Kar 1970, p. 129): Pollen grains oval with equally rounded lateral ends. 38-45 x 35-40  $\mu\text{m}$ . Monocolpate, colpus distinct, uniformly broad, restricted in middle region, not



extending more than two-thirds along longer axis. Exine up to 2  $\mu\text{m}$  thick, intragranulose, intrastructure well recognizable.

**Indian records:** Sah and Kar 1970: 129, plate 1, figure 13, Naredi Formation (Early Eocene), Kutch District, Gujarat; Kar 1978: 163, 167, Naredi and Harudi formations (Early-Middle Eocene), Kutch District, Gujarat; Saxena 1979: 133, Matanomadh Formation (Palaeocene), Matanomadh, Kutch District, Gujarat; Phadtare and Kulkarni 1980: 160, plate 2, figure 12, Ratnagiri Beds (Miocene), Ratnagiri-Pawas Road near Third Dharmshala stop 10 km south of Ratnagiri, Ratnagiri District, Maharashtra; Kar 1985: 18, 37, 57, 112, plate 12, figure 2, Matanomadh, Naredi and Harudi formations (Palaeocene-Eocene), Matanomadh, bore core nos. 13 and 15 near Baranda, Panandhro, Akri, bore core nos. 1 and 2 near Lakhpat and Harudi, Kutch District, Gujarat; Singh et al. 1985: 32, Barail Group (Oligocene), Assam and Meghalaya; Prasad and Dey 1986: 69, Eocene, nala sections around Yinkiong and Dalbuing, East Siang District, Arunachal Pradesh; Raha et al. 1987: 217, plate 1, figures 4-5, Eocene, Ambalapuzha borehole, Kerala; Mandal 1990: 325, Lakadong Sandstone Member, Sylhet Limestone Formation (Palaeocene), Thanjinath, Khasi Hills, Meghalaya; Kar and Bhattacharya 1992: 251, Early Eocene, Rajpardi lignite mine, Cambay Basin, Gujarat; Mandaokar 1993: 139, plate 1, figure 1, Tikak Parbat Formation (Late Oligocene), Dangri Kumari Colliery, Dibrugarh District, Assam; Shanmukhappa and Koshal 1993: 200, 201, Ankleshwar Formation (Middle Eocene), Gandhar area, Broach Depression, Cambay Basin, Gujarat; Hait and Banerjee 1994: 115, plate 1, figure 8, Early Miocene, near Suangpuilawn village about 20 km north-east of Aizawl, Mizoram; Kar et al. 1994: 186, Tertiary, subsurface sediments in Upper Assam; Misra and Kapoor 1994: 153, plate 2, figure 24, Subathu and Basal Dharmshala (Palaeocene-Early Eocene), Jwalamukhi-B Well, northern part of Jwalamukhi Structure, Himachal Pradesh; Mandaokar 1996: 41, Tikak Parbat Formation (Late Oligocene), Dilli-Jeypore Colliery, Dilli-Jeypore Coalfields, Dibrugarh District, Assam; Aswal and Singh 2000: 124, Middle Eocene, Saripalli Well-A, Krishna-Godavari Basin, Andhra

Pradesh; Mandaokar 2000b: 181, Tikak Parbat Formation (Late Oligocene), Jeypore Colliery, Dilli-Jeypore Coalfields, Dibrugarh District, Assam; Mandaokar 2000c: 38, Tikak Parbat Formation (Late Oligocene), Namchik River Section, Changlang District, Arunachal Pradesh; Mitra et al. 2000: 126, plate 1, figure 18, Siwalik Group (Neogene), Darjeeling Foothills, Eastern Himalaya; Samant 2000: 114, Kharsalia Clay Formation (Early Eocene), near Bhavnagar, Cambay Basin, Gujarat; Samant and Tapaswi 2001: 128, Surat lignite, Cambay Shale Formation (Early Eocene), Tarkeshwar, Surat District and Valia, Bharuch District, Gujarat; Mandaokar 2002a: 116, Dulte Formation (Early Miocene), 2 km from Dulte village on Dulte-Keifang Road, Aizawl District, Mizoram; Tripathi et al. 2003: 91, Akli Formation (Late Palaeocene), Barmer Basin, Rajasthan; Chakraborty 2004: 115, plate 1, figure 1, Lakadong Sandstone (Late Palaeocene), around Bhalukurung, North Cachar Hills, Assam; Tripathi et al. 2009: 152, Akli Formation (Early Palaeocene), Barmer Basin, Rajasthan.

***Monocolpopollenites plicatus* (Sah & Kar 1970)  
Saxena, comb. nov.**

**Basionym:** *Palmaepollenites plicatus* Sah & Kar, *Palaeobotanist* 18(2): 129, plate 1, figures 14-15. 1970.

**Original description** (Sah & Kar 1970, p. 129): Pollen grains mostly elliptical, sometimes oval, with equally broad lateral ends. 48-60 x 20-40  $\mu\text{m}$ . Monocolpate, colpus end to end, closed or slightly open at ends, associated with folds. Exine up to 2  $\mu\text{m}$  thick, laevigate, sometimes weakly intrastructured.

**Indian records:** Sah and Kar 1970: 129, plate 1, figures 14-15, Naredi Formation (Early Eocene), Kutch District, Gujarat; Mathur and Pant 1973: 858, figure 3, Palaeocene-Eocene, Kutch District, Gujarat; Kar 1978: 163, 167, Naredi and Harudi formations (Early-Middle Eocene), Kutch District, Gujarat; Saxena 1979: 133, plate 2, figure 18, Matanomadh Formation (Palaeocene), Matanomadh, Kutch District, Gujarat; Nandi 1980: 734, plate 1, figure 6, Lower Siwalik (Miocene), Punjab, Himachal Pradesh and Uttar Pradesh; Kar 1985: 18, 37, 57, 112, Matanomadh, Naredi and Harudi formations (Palaeocene-Eocene),



Matanomadh, bore core no. 15 near Baranda, bore core no. 1 near Lakhpatt and Harudi, Kutch District, Gujarat; Singh et al. 1985: 32, Barail Group (Oligocene), Assam and Meghalaya; Mandaokar 1993: 139, plate 2, figure 24, Tikak Parbat Formation (Late Oligocene), Dangri Kumari Colliery, Dibrugarh District, Assam; Mitra et al. 2000: 126, plate 1, figure 16, Siwalik Group (Neogene), Darjeeling Foothills, Eastern Himalaya; Saxena 2000: 163, plate 2, figure 17, Sindhudurg Formation (Miocene), Mavli Mine at Redi, Sindhudurg District, Maharashtra; Saxena and Sarkar 2000: 257, plate 2, figure 2, Siju Formation (Middle Eocene), Simsang River Section near Siju, South Garo Hills District, Meghalaya; Mandaokar 2002a: 116, Dulte Formation (Early Miocene), 2 km from Dulte village on Dulte-Keifang Road, Aizawl District, Mizoram; Gupta et al. 2003: 211, Palaeocene-Eocene, Ganga Basin; Saxena and Khare 2004: 74, Late Palaeocene-Middle Eocene, Jayamkondacholapuram Well 12, Tiruchirapalli District, Tamil Nadu.

***Monocolpopollenites ratnagiriensis* (Kulkarni et al. 1985) Saxena, comb. nov.**

**Basionym:** *Palmaepollenites ratnagiriensis* Kulkarni et al., in Varghese T. M. (Editor) - Recent Advances in Pollen Research, Allied Publishers Private Limited: 297, plate 1, figure 1. 1985.

**Original description** (Kulkarni et al. 1985, p. 297): Pollen grains heteropolar, biconvex in equatorial view, monosulcate, 35.0 x 49.0  $\mu\text{m}$ , sulcus prominently wide, 16.6 x 45.7  $\mu\text{m}$ , ends pointed, crassimarginate, exine about 2.5  $\mu\text{m}$  thick, sexine thicker than nexine, psilate.

**Indian records:** Kulkarni et al. 1985: 297, plate 1, figure 1, Ratnagiri Beds (Miocene), well 10 km south of Ratnagiri on Ratnagiri-Pawas Road, Ratnagiri District, Maharashtra.

***Monocolpopollenites samantiae* Saxena, nom. nov.**

$\equiv$  *Palmaepollenites elongatus* Samant & Phadtare, Palaeontographica Abt. B 245(1-6): 38, plate 7, figure 19. 1997, nom. illegit., non Kulkarni et al. 1985.

**Original description** (Samant & Phadtare 1997,

p. 38): Pollen grains heteropolar, prolate, appear like pea pod, 40-45 x 26-30  $\mu\text{m}$ , monosulcate; sulcus extending from end to end, obliquely placed, narrow, almost closed, crassimarginate, margins regular, smooth; exine about 1-2  $\mu\text{m}$  thick, generally nexine is thicker than sexine, sometimes along sulcus ends the nexine is thinner or of almost same thickness as the sexine; psilate to micropunctate.

**Indian records:** Samant and Phadtare 1997: 38, plate 7, figure 19, Tarkeshwar Formation (Early Eocene), Rajpardi, Cambay Basin, Gujarat; Samant 2000: 114, plate 4, figure 5, Kharsalia Clay Formation (Early Eocene), near Bhavnagar, Cambay Basin, Gujarat.

**Remarks:** *Palmaepollenites elongatus* Samant & Phadtare 1997 is a junior homonym of *Palmaepollenites elongatus* Kulkarni et al. 1985. Since both these species are being combined with *Monocolpopollenites*, a new name is here proposed for *Palmaepollenites elongatus* Samant & Phadtare, non Kulkarni et al. 1985.

***Monocolpopollenites slimslitus* (Baksi 1962) Saxena, comb. nov.**

**Basionym:** *Palmaepites slimsliti* Baksi, Bull. Geol. Min. Metall. Soc. India 26: 16, plate 1, figure 4. 1962.

**Original description** (Baksi 1962, p. 16): Equatorial compression; long diameter 39  $\mu\text{m}$ , psilate; monocolpate, colpus – a pole to pole narrow uniform slit.

**Indian records:** Baksi 1962: 16, plate 1, figure 4, Tertiary, Simsang River Section, South Shillong Front, Meghalaya; Ghosh 1969: 131, plate 1, figure 29, Tura Formation (Early Eocene), Daranggiri and Rongrenggiri, Garo Hills, Meghalaya.

***Monocolpopollenites subtilis* (Salujha et al. 1972) Kumar & Takahashi 1991**

**Synonym:** *Palmaepollenites subtilis* Salujha et al. 1972, in Ghosh A. K. et al. (Editors) - Proceedings of the Seminar on Paleopalynology and Indian Stratigraphy, Calcutta, 1971, Botany Department, Calcutta University: 278-279, plate 2, figures 53-54. 1972.



**Original description** (Salujha et al. 1972, p. 278-279): Golden-yellow, oval, measuring 35.2-58 x 25.6-32  $\mu\text{m}$ ; monosulcate, sulcus 6.2-8.5  $\mu\text{m}$  wide, running from one pole to other; exine over 1  $\mu\text{m}$  thick, smooth to faintly structured.

**Indian records:** Salujha et al. 1972: 278-279, plate 2, figures 53-54, Palaeogene, Garo Hills, Meghalaya; Salujha et al. 1974: 275, plate 2, figure 47, Palaeogene, Khasi and Jaintia Hills, Meghalaya; Salujha et al. 1977: 124, Bokabil Subgroup and Tipam Group (Late Miocene-Late Pliocene), Gojalia Anticline, South Tripura District, Tripura; Salujha and Kindra 1981: 57, plate 1, figures 15-17, Langpar Formation (Palaeocene), Umsohryngkew and Umiew River Sections, Khasi Hills, Meghalaya; Salujha and Kindra 1984: 396, plate 2, figure 35, Miocene, Atharmura Anticline, Tripura; Dogra et al. 1985: 69, plate 2, figures 35, 44, 48, Dharmsala Beds (Oligo-Miocene), Dharmsala, Kangra District, Himachal Pradesh; Salujha and Kindra 1986: 245, plate 2, figure 36, Oligocene-Miocene, Silchar-Haflong Road Traverse, Cachar District, Assam; Kumar and Takahashi 1991: 554, plate 2, figure 3, Renji Formation (Late Oligocene), Silchar-Haflong Road Section, Assam; Salujha et al. 1991: 66, plate 1, figure 35, Neogene, Adamtila Well-A, Cachar District, Assam; Kumar 1994: 17, plate 4, figures 10, 19, Laisong Formation (Early Oligocene), Silchar-Haflong Road Section, Assam; Kapoor et al. 2003: 182, Dharmsala and Siwalik (Oligocene-Neogene), Dharmsala and Nurpur areas, Kangra District, Himachal Pradesh.

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