

Cicatricosporites Pflug & Thomson vs. *Schizaeosporites* Potonié ex Delcourt & Sprumont (striate-monolete fossil spores of Schizaeaceae): nomenclature, new combinations and Indian records

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ABSTRACT

Saxena R. K. 2010: *Cicatricosporites* Pflug & Thomson vs. *Schizaeosporites* Potonié ex Delcourt & Sprumont (striate-monolete fossil spores of Schizaeaceae): nomenclature, new combinations and Indian records. *Geophytology* 39(1-2): 87-96.

The nomenclatural position of *Cicatricosporites* Pflug & Thomson in Thomson & Pflug 1953 and *Schizaeosporites* Potonié ex Delcourt & Sprumont 1955, is discussed and it is inferred that the latter is an obligate junior synonym of the former. Eighteen species described from the Indian sediments are transferred to *Cicatricosporites*. These are: *Cicatricosporites bengalensis* (Mathur & Chopra) Saxena, comb. nov., *Cicatricosporites crassimurus* (Dutta & Sah) Saxena, comb. nov., *Cicatricosporites digitatoides* (Cookson) Saxena, comb. nov., *Cicatricosporites ghoshii* (Ramanujam) Saxena, comb. nov., *Cicatricosporites grandiformis* (Ramanujam) Saxena, comb. nov., *Cicatricosporites grandistriatus* (Ramanujam) Saxena, comb. nov., *Schizaeosporites jugendicus* (Mathur & Chopra) Saxena, comb. nov., *Cicatricosporites kashmiriensis* (Lukose) Saxena, comb. nov., *Cicatricosporites minimus* (Ramanujam) Saxena, comb. nov., *Cicatricosporites multistriatus* (Rao & Ramanujam) Saxena, comb. nov., *Cicatricosporites palanaensis* (Sah & Kar) Saxena, comb. nov., *Cicatricosporites perforatus* (Naskar & Baksi) Saxena, comb. nov., *Cicatricosporites phaseolus* (Delcourt & Sprumont) Saxena, comb. nov., *Cicatricosporites sahilii* (Samant & Phadtare) Saxena, comb. nov., *Cicatricosporites sarnuensis* (Naskar & Baksi) Saxena, comb. nov., *Cicatricosporites sinuata* (Ramanujam) Saxena, comb. nov., *Cicatricosporites striaei* (Baksi) Saxena, comb. nov. and *Cicatricosporites suratensis* (Samant & Tapaswi) Saxena, comb. nov. All the Indian records of this genus are enumerated.

Key-words: *Cicatricosporites*, *Schizaeosporites*, striate-monolete spores, Schizaeaceae, Mesozoic-Cenozoic, India.

INTRODUCTION

The fern family Schizaeaceae is well documented in fossil records. Although its macrofossil evidences are not many, but there is an extensive spore record in the Late Mesozoic and Cenozoic sediments. Spores with a coarsely striate exine of possible affinity with *Schizaea* first appear in the Triassic, but the diversity of this spore type does not increase significantly until the Early Cretaceous. These spore data indicate that some living species or species groups may have had much greater ranges in the past. Schizaeaceae produces spores with wide range of morphological variations. They are either trilete or monolete and have exine ornamented with

striae, verrucae, cristae and variety of other sculpture types. The fossil monolete, striate schizaeaceous spores are placed under two genera, viz. *Cicatricosporites* Pflug & Thomson in Thomson & Pflug 1953 and *Schizaeosporites* Potonié ex Delcourt & Sprumont (1955). The nomenclatural status of these genera is discussed ahead.

CICATRICOSPORITES VERSUS *SCHIZAEOSPORITES*

Cicatricosporites Pflug & Thomson in
Thomson & Pflug 1953

Type species: *Cicatricosporites eocenicus*

(Selling 1944) Jansonius & Hills 1976

Schizaea? eocenica Selling 1944, p. 66, plate 4, figure 44.

Sporites dorogensis Potonié 1934, plate 1, figure 22.

Schizaeoisporites pseudodorogensis Potonié 1951, p. 144, plate 20, figure 19 (gen. et sp. nov.).

Cicatricosporites pseudodorogensis (Potonié 1951) Thomson & Pflug 1953, p. 61.

The genus *Cicatricosporites* was instituted by Pflug and Thomson in Thomson and Pflug (1953) for monolete, striate schizaeaceous spores. In the "Division Monoletes Ibrahim", Thomson and Pflug (1953) gave the following diagnosis: "Cicatricose or canaliculate sculpture or structure". Selling (1944, 66) described *Schizaea? eocenica* Selling 1944, the basionym of the type species, as follows: Spore monolete, measuring about 60 x 38 µm. Dehiscence mark bordered by one ridge on each side. The rest of the exospore surface covered by other, more or less longitudinal ridges, only slightly spiral and about 2 µm broad. Furrows between them measure about one-fourth of this. Potonié (1956, p. 81) formulated the diagnosis as follows: Type 59 microns; monolete microspores, cicatricose to canaliculate, i.e. exine with very regular, parallel, narrow ribs which are separated by canals or narrow grooves. On either side of the monolete mark is a rib; the other ribs also more or less parallel to the monolete mark, somewhat converging in the direction of the narrow ends of the equator, which may result in a slight spiralling. Potonié (1960, p. 70) emended the diagnosis of this genus, also to accommodate spores having parallel ribs broken into cristae (rows of verrucae). Krutzsch (1959, p. 227) also published a detailed description.

***Schizaeoisporites* Potonié 1951 ex Delcourt & Sprumont 1955**

Type species: *Schizaeoisporites eocenicus* (Selling 1944) Potonié 1956

Schizaea? eocenica Selling 1944, p. 66, plate 4, figure 44.

Sporites dorogensis in Potonié 1934, plate 1, figure 22.

Holotype re-illustrated in Potonié (1951, p. 144,

plate 20, figure 19) and also in Krutzsch (1954, p. 291, plate 2, figures 1-3)

The generic name *Schizaeoisporites* was published by Potonié (1951, p. 144) for monolete, striate schizaeaceous spores. This generic name, however, cannot be accepted as validly published as its type was published earlier. A new monotypic genus, not based on a new species, must be validated with diagnosis which is lacking in Potonié (1951). Delcourt & Sprumont (1955, p. 46) validated the genus by giving the following diagnosis: Monolete spores with cicatrices or channels, analogous to those of *Cicatricosisporites*

Nomenclatural comments: Selling (1944, p. 66) gave a new name to the monolete ribbed spore illustrated by Potonié 1934 and based a new species of *Schizaea* on it (*Schizaea? eocenica* Selling 1944). Unaware of this, Potonié (1951 p. 144) erected a new genus *Schizaeoisporites* based on the very same specimen, referring to its earlier description (Potonié 1934). As already explained, this generic name cannot be accepted as validly published. The validation of the generic name by Delcourt & Sprumont (1955) was predated by the publication of *Cicatricosporites* Pflug & Thomson in Thomson & Pflug 1953. Since both the genera, *Cicatricosporites* Pflug & Thomson and *Schizaeoisporites* Potonié ex Delcourt & Sprumont, are based on the same type species, the later published generic name (*Schizaeoisporites*) is illegitimate (being a homotypic synonym) and must be rejected in favour of former. Consequently, eighteen species described from the Indian sediments, under the generic name *Schizaeoisporites*, are here transferred to *Cicatricosporites*.

CICATRICOSOPORITES SPECIES FROM INDIA

***Cicatricosporites bengalensis* (Mathur & Chopra 1982) Saxena, comb. nov.**

Basionym: *Schizaeoisporites bengalensis* Mathur & Chopra, Geoscience Jl. 3: 68, plate 3, figure 58. 1982.

Description (Mathur & Chopra 1982, p. 68): Equatorial outline oval-elliptical, size 70-80 x 40-50 µm, monolete, suture obscure, not extending up to the

periphery, exine thin, ornamented with less than 1 μm thick and closely placed ridges, ridges parallel to each other but obliquely disposed to the laesura.

Indian records: Mathur and Chopra 1982: 68, plate 3, figure 58, Late Miocene-Early Pliocene, Offshore Well BB-A-1, Bay of Bengal.

Cicatricosporites crassimurus (Dutta & Sah 1970) Saxena, comb. nov.

Basionym: *Schizaeosporites crassimurus* Dutta & Sah, Palaeontographica Abt. B 131: 24, plate 3, figures 32-34. 1970.

Description (Dutta & Sah 1970, p. 24): (Diagnosis): Size range 30-40 μm ; holotype 27 x 32 μm ; amb ovoid-elongate to bean shaped, extremities rounded; monolete, laesura long, about $\frac{3}{4}$ the longer axis; exine thin, surface ornamented with few and rather thick ridges, oriented obliquely to the laesura, but parallel to one another. (Description): Miospores bilateral, monolete. Equatorial outline ovoid-elongate to sometimes reniform. Monolete generally fairly distinct, sometimes obscured by sculptural elements, laesura long, 23-32 μm in length, lips bordered by slightly raised ridges, contact area generally smooth. Exine up to 1.5 μm thick, sculptural elements composed of thick parallel muri, 7-12 in number, muri sometimes bifurcating. Muri 2-4 μm thick, intervening spaces 1-1.5 μm wide.

Indian records: Dutta and Sah 1970: 24, plate 3, figures 32-34, Cherra Formation (Palaeocene), Umstew, Shillong Plateau, Meghalaya; Kar and Kumar 1986: 178, Lakadong Sandstone (Palaeocene), Khasi Hills, Meghalaya; Mandal 1987: 196, Lakadong Sandstone (Palaeocene), Sutunga, Jaintia Hills District, Meghalaya; Mandal 1990: 325, Lakadong Sandstone Member, Sylhet Limestone Formation (Palaeocene), Thanjinath, Khasi Hills, Meghalaya; Singh 1990: 219, Tura Formation (Palaeocene), Langrin Coalfield, Khasi Hills, Meghalaya; Mandaokar 1993: 139, pl 2, fig 8, Tikak Parbat Formation (Late Oligocene), Dangri Kumari Colliery, Dibrugarh District, Assam; Kumar 1994: 206, Lakadong Sandstone (Palaeocene), Jarain and Laitrymbai, Jaintia Hills District, Meghalaya; Mandaokar 1996: 41, Tikak Parbat Formation (Late Oligocene), Dilli-Jeypore Colliery, Dilli-Jeypore

Coalfields, Dibrugarh District, Assam; Mandaokar 2000a: 180, Tikak Parbat Formation (Late Oligocene), Jeypore Colliery, Dilli-Jeypore Coalfields, Dibrugarh District, Assam; Mandaokar 2000b: 45, pl 2, fig 13, Tikak Parbat Formation (Late Oligocene), Namchik River Section, Changlang District, Arunachal Pradesh; Mandaokar 2002b: 21, Tikak Parbat Formation (Late Oligocene), Borjan Coalfield, Nagaland.

Cicatricosporites digitatoides (Cookson 1957) Saxena, comb. nov.

Basionym: *Schizaea digitatoides* Cookson, Proc. Royal Soc. Victoria 69: 44, plate 9, figure 1. 1957.

Schizaeosporites digitatoides (Cookson 1957) Potonié, Beih. Geol. Jb. 39: 70. 1960.

Indian records: Ramanujam 1967: 35, figures 25-27, Cuddalore Series (Miocene-Pliocene), Neyveli, South Arcot District, Tamil Nadu; Sah and Dutta 1968: 186, plate 1, figure 15, Palaeogene, Assam; Ramanujam 1972: 250, plate 1, figure 8, Warkalli lignite (Miocene), Warkalli, Quilon District, Kerala; Singh 1977: 193, Tura Formation (Palaeocene), Nongwal Bibra, Garo Hills, Meghalaya; Rawat et al. 1977: 186, Kadi Formation (Early Eocene), Cambay Basin, Gujarat; Ramanujam and Rao 1977: 161, Warkalli Beds (Early-Middle Miocene), Kerala; Naskar and Baksi 1978: 317, plate 1, figure 11, Akli Formation; (Palaeocene-Eocene); near Kapurdi, Barmer District, Rajasthan; Baksi and Deb 1980: 205, plate 4, figure 34, : Jalangi and Sylhet limestone formations (Eocene), Bengal Basin, West Bengal; Siddhanta 1986: 64, plate 1, figure 3, Neyveli Formation (Palaeocene-Eocene), Neyveli, South Arcot District, Tamil Nadu; Ramanujam 1987: 36, Warkalli Beds (Miocene), Kerala; Sarma and Ramanujam 1988: 144, figure 17, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu; Saxena and Khare 2004: 73, Late Palaeocene-Middle Eocene, Jayamkondacholapuram Well 12, Tiruchirapalli District, Tamil Nadu.

Cicatricosporites eocenicus (Selling 1944) Jansonius & Hills 1976

Synonym: *Schizaeosporites eocenicus* (Selling 1944) Potonié 1956.

Description (Selling 1944, p. 66): Spore monolete, measuring about 60 μm (59 μm ?; largest equatorial diameter) x 38 μm (smallest d:o); polar diameter unknown. Dehiscence mark bordered by one ridge on each side. The rest of the exospore surface covered by other, more or less longitudinal ridges, only slightly spiral and about 2 μm broad. Furrows between them measure about one-fourth of this.

Indian records: Dutta and Sah 1970: 24, plate 3, figure 35, Cherra Formation (Palaeocene), Umstew, Shillong Plateau, Meghalaya; Venkatachala and Sharma 1974a: 193, Late Cretaceous, Pondicherry area, Cauvery Basin, Tamil Nadu; Venkatachala and Sharma 1974b: 170, plate 1, figure 13, Late Cretaceous, Kallamedu, well, Vridhachalam area, Cauvery Basin, Tamil Nadu; Siddhanta 1986: 64, plate 1, figure 4, Neyveli Formation (Palaeocene-Eocene), Neyveli, South Arcot District, Tamil Nadu; Misra and Kapoor 1994: 152, 155, 159, plate 1, figures 2-3, Subathu and Basal Dharmasala and Lower Dharmasala (Palaeocene-Early Eocene and Middle Eocene, Jwalamukhi-B Well, northern part of Jwalamukhi Structure, Himachal Pradesh; Acharya 2000: 22, Early Eocene, Borehole No. MII 128, Mannargudi area, Thanjavur District, Cauvery Basin, Tamil Nadu.

***Cicatricosporites ghoshii* (Ramanujam 1967)
Saxena, comb. nov.**

Basionym: *Schizaeoisporites ghoshii* Ramanujam, Palynol. Bull. 2-3: 35, figure 28. 1967.

Description (Ramanujam 1967, p. 35): Spores golden-yellow, monolete, lateral view plano-convex, proximal view almost oblong 50-55 x 22-26 μm (E_1 x P). Laesura surrounded by a ridge, fairly broad and extending the whole of the E_1 axis, ends pointed. Exosporium 2.5-4.5 μm thick, surface prominently striate; striae longitudinally oblique, often almost parallel, relatively few in number, widely spaced. Ridges considerably broad, simple or occasionally bifurcated. Grooves much narrower than ridges.

Indian records: Ramanujam 1967: 35, figure 28, Cuddalore Series (Miocene), Neyveli, South Arcot District, Tamil Nadu; Sarma and Ramanujam 1988: 144, figure 10, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu.

***Cicatricosporites grandiformis* (Ramanujam 1972) Saxena, comb. nov.**

Basionym: *Schizaeoisporites grandiformis* Ramanujam in Ghosh A. K. et al. (Editors) - Proceedings of the Seminar on Paleopalynology and Indian Stratigraphy, Calcutta, 1971: 251, plate 1, figure 10. 1972.

Description (Ramanujam 1972, p. 251): Spores golden-yellow, monolete, plano-convex, large, 60-72 x 30-40 μm , proximal view broadly oval; laesura conspicuous with blunt ends, long, almost reaching both ends of spore. Exosporium 3.5 μm thick, surface finely striated due to numerous obliquely longitudinal ridges and grooves. Ridges fine, (1 μm thick), closely spaced, either simple or forked.

Indian records: Ramanujam 1972: 251, plate 1, figure 10, Warkalli lignite (Miocene), Warkalli, Quilon District, Kerala; Kar and Singh 1986: 107, plate 8, figures 5, 19, Mahadek Formation (Late Cretaceous), Nongnah, Pungtung-Lyngkhat Road Section, Meghalaya; Ramanujam 1987: 36, Warkalli Beds (Miocene), Kerala; Sarma and Ramanujam 1988: 144, figure 18, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu; Singh et al. 1992: 56, pl 1, fig 5, Cuddalore Formation (Miocene), Neyveli Lignite field, Tamil Nadu; Ramanujam et al. 1991: 53, Early Miocene, Pattanakad Borewell, Alleppey District, Kerala.

***Cicatricosporites grandistriatus* (Ramanujam 1972) Saxena, comb. nov.**

Basionym: *Schizaeoisporites grandistriatus* Ramanujam in Ghosh A. K. et al. (Editors) - Proceedings of the Seminar on Paleopalynology and Indian Stratigraphy, Calcutta, 1971: 251, plate 1, figures 11-12. 1972.

Description (Ramanujam 1972, p. 251): Spores brownish-yellow, plano- to faintly concavo-convex, proximal view oval to elliptical, 20-28.5 x 18-24 μm . Laesura conspicuous, long, almost reaching both ends of spore along its longest axis, laesura margins thick-walled and slightly raised, ends pointed. Exosporium 2 μm thick, surface longitudinally and coarsely striated due to ridges and grooves. Ridges straight to slightly

slanting, seldom fork, 3-4.5 μm thick, few in number (5-7), widely spaced; grooves 2.5-5 μm thick, conspicuous.

Indian records: Ramanujam 1972: 251, plate 1, figures 11-12, Warkalli lignite (Miocene), Warkalli, Quilon District, Kerala; Ramanujam 1987: 36, Warkalli Beds (Miocene), Kerala; Sarma and Ramanujam 1988: 144, figure 9, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu.

***Schizaeosporites jugendicus* (Mathur & Chopra 1982) Saxena, comb. nov.**

Basionym: *Schizaeosporites jugendicus* Mathur & Chopra, Geoscience Jl. 3: 68, plate 3, figure 59. 1982.

Description (Mathur & Chopra 1982, p. 68): Spores \pm plano-convex in lateral view; size 44-50 x 17-24 μm , monolete, laesura long, extending almost from end to end of the longer axis, striated, ridges less than 1 μm thick, closely disposed parallel to the laesura.

Indian records: Mathur and Chopra 1982: 68, plate 3, figure 59, Pleistocene-Recent, Diamond Harbour Well No.1, depth 260 - 265 m., West Bengal.

***Cicatricosporites kashmiriensis* (Lukose 1964) Saxena, comb. nov.**

Basionym: *Schizaea kashmiriensis* Lukose, Nature 204(4958): 566, figure 1, 1964.

Description (Lukose 1964, p. 566): The spore is large, bilateral and bean-shaped; monolete, laesura long; exine sculptured with unbranched broad striations. Striations 4 μm thick are spaced about 3.5-4 μm and parallel to each other and run along the long axis of the spore. Length, 85.8 μm ; breadth, 39 μm ; broad end, 42.9 μm ; narrow end, 31.2 μm .

Indian records: Lukose 1964: 566, figure 1, Late Jurassic, Wakkachu Traverse, Ladakh District, Jammu and Kashmir; Ghosh and Lukose 1967: 239, plate 1, figure 1, Late Jurassic, Wakkachu Traverse, Ladakh District, Jammu and Kashmir.

***Cicatricosporites minimus* (Ramanujam 1967) Saxena, comb. nov.**

Basionym: *Schizaeosporites minimus* Ramanujam, Palynol. Bull. 2-3: 35, figures 5, 29. 1967.

Description (Ramanujam 1967, p. 35): Spores

colourless, monolete, lateral view plano-convex to faintly biconvex, proximal view elliptical, 33 x 23 μm (E_1 x P). Laesura very narrow, surrounded by a ridge, deep, fairly long, ends rather blunt. Exosporium 1.5-2 μm thick, surface striated; striae fine, closely spaced, rarely forked. Ridges and grooves more or less of same thickness (1 μm thick).

Indian records: Ramanujam 1967: 35, figures 5, 29, Cuddalore Series (Miocene), Neyveli, South Arcot District, Tamil Nadu; Ramanujam 1972: 250, plate 1, figure 9, Warkalli lignite (Miocene), Warkalli, Quilon District, Kerala; Saxena and Khare 2004: 73, Late Palaeocene-Middle Eocene, Jayamkondacholapuram Well 12, Tiruchirapalli District, Tamil Nadu.

***Cicatricosporites multistriatus* (Rao & Ramanujam 1978) Saxena, comb. nov.**

Basionym: *Schizaeosporites multistriatus* Rao & Ramanujam, Palaeobotanist 25: 409, plate 3, figure 30. 1978.

Description (Rao & Ramanujam 1978, p. 409): Spores golden yellow, plano-convex laterally, 41-50 x 25-30 μm , monolete, laesura long, reaching both ends of spore, margins slightly thickened, ends pointed to blunt. Exosporium 1.5 μm thick, surface with numerous longitudinal striae formed of extremely fine grooves; striae essentially simple, straight to locally slanting.

Indian records: Rao and Ramanujam 1978: 409, plate 3, figure 30, Quilon Beds (Miocene), Padappakkara, Quilon District, Kerala; Sarma and Ramanujam 1988: 144, figure 11, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu; 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; Mandaokar 1993: 139, Tikak Parbat Formation (Late Oligocene), Dangri Kumari Colliery, Dibrugarh District, Assam; Rao et al. 1995: 372, Early Miocene, Borewell at Kulasekharamangalam, Kottayam District, Kerala; Samant and Phadtare 1997: 12, pl 2, fig 4, Tarkeshwar Formation (Early Eocene), Rajpardi, Cambay Basin, Gujarat; Samant 2000: 104, pl 1, fig 14, 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.

***Cicatricosporites palanaensis* (Sah & Kar 1974) Saxena, comb. nov.**

Basionym: *Schizaeoisporites palanaensis* Sah & Kar, *Palaeobotanist* 21: 164, plate 1, figures 4-5. 1974.

Description (Sah & Kar 1974, p. 164): Spores \pm elliptical, 40-55 μm ; Monolete distinct or indistinct, extending up to three-fourths along longer axis. Exine 1.5-2.5 μm thick, ribs 8-14, well developed, 3-7 μm broad, parallel to each other, mostly extending from one end to other.

Indian records: Sah and Kar 1974: 164, plate 1, figures 4-5, Palana lignite, (Early Eocene); Bikaner District, Rajasthan; Kar and Kumar 1986: 178, Lakadong Sandstone (Palaeocene), Khasi Hills, Meghalaya; Kar and Sharma 2001: 129, plate 1, figures 11-12, Palana Formation (Late Palaeocene-Early Eocene), Bikaner-Nagaur area, Bikaner District, Rajasthan.

***Cicatricosporites perforatus* (Naskar & Baksi 1978) Saxena, comb. nov.**

Basionym: *Schizaeoisporites perforatus* Naskar & Baksi, *Palaeobotanist* 25: 317-318, plate 2, figure 14. 1978.

Description (Naskar & Baksi 1978, p. 317-318): Spores monolete, 24-26 x 30-33 μm ; lateral view concavo-convex; lete long, slender with pointed ends. Exine 1 μm thick, surface distinctly striated, striae closely spaced, longitudinally oblique, pitted, pits distributed uniformly throughout the surface, ridges thin, grooves comparatively thicker (1.5 μm) than the ridges.

Indian records: Naskar and Baksi 1978: 317-318, plate 2, figure 14, Akli Formation; (Palaeocene-Eocene); near Kapurdi, Barmer District, Rajasthan; Sarma and Ramanujam 1988: 144, figure 4, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu; Ramanujam et al. 1991: 3, pl 1, fig 17, Neogene, Mynagapalli Borewell, Quilon District, Kerala.

***Cicatricosporites phaseolus* (Delcourt & Sprumont 1955) Saxena, comb. nov.**

Basionym: *Schizaeoisporites phaseolus* Delcourt & Sprumont, *Mem. Soc. Belg. Geol.* 4(5): 46, figure 13. 1955.

Description (Delcourt & Sprumont 1955, p. 46): Laterally, many of the striations go oblique to the dehiscence mark and contour of the spore. At the ends of the dehiscence mark, striations radiate in several directions. Spores very dark. As in *Cicatricosisporites*, the superposition of the two sides gives a quadrille. Length: 59-68 μm . Width: 35-50 μm .

Indian records: Dutta and Sah 1970: 24, plate 3, figure 31, Cherra Formation (Palaeocene), Shillong Plateau, Meghalaya; Ramanujam and Rao 1977: 161, Warkalli Beds (Early-Middle Miocene), Kerala; Siddhanta 1986: 64, plate 1, figure 2, Neyveli Formation (Palaeocene-Eocene), Neyveli, South Arcot District, Tamil Nadu; Mandal 1987: Lakadong Sandstone (Palaeocene), Sutunga, Jaintia Hills, Meghalaya; Ramanujam 1987: 28, plate 1, figure 4, Warkalli Beds (Miocene), Kerala; Sarma and Ramanujam 1988: 144, figure 19, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu; Mandal 1990: 325, PALAEOCENE (Lakadong Sandstone Member, Sylhet Limestone Formation), Thanjinath, Khasi Hills, Meghalaya; Mandal et al. 1996: 80, age not mentioned, mud volcano in Baratang Island, Andaman and Nicobar Islands; Mandal 1997: 99, Barail Group (Late Eocene), Mariani-Mokokchung Road, Mokokchung District, Nagaland; Mandaokar 1999: 241, Disang Group (Late Eocene), Tirap River Section, Tinsukia District, Assam; Mandaokar 2002a: 116, Dulte Formation (Early Miocene), 2 km from Dulte village on Dulte-Keifang Road, Aizawl District, Mizoram.

***Cicatricosporites sahilii* (Samant & Phadtare 1997) Saxena, comb. nov.**

Basionym: *Schizaeoisporites sahilii* Samant & Phadtare, *Palaeontographica Abt. B* 245(1-6): 12-13, plate 2, figure 5. 1997.

Description (Samant & Phadtare 1997, p. 12-13): (Diagnosis): Spores oval, monolete; laesura more

than 2/3 of the spore length, thick margined; exosporium 2-5 μm thick, striate, striations parallel to laesura. (Description): Spores almost oval in shape, about 34-38 x 43-50 μm in size, monolete; laesura long, more than 2/3 of the longer axis of the spore (about 32 μm long), closed, ends pointed, thick margined; exosporium about 2 μm thick, striate, striations almost parallel, rarely bifurcating.

Indian records: Samant and Phadtare 1997: 12-13, plate 2, figure 5, Tarkeshwar Formation (Early Eocene), Rajparadi, Cambay Basin, Gujarat.

Cicatricososporites sarnuensis (Naskar & Baksi 1978) Saxena, comb. nov.

Basionym: *Schizaeosporites sarnuensis* Naskar & Baksi, Palaeobotanist 25: 317, plate 1, figures 12-13. 1978.

Description (Naskar & Baksi 1978, p. 317): Spores monolete, 28-30 x 42-46 μm ; lateral view plano-convex, proximal view oval; lete long, extending almost end to end, slender with pointed ends. Exine 1.5 μm thick, surface prominently striated, striae widely spaced, 14-16 in number, longitudinally oblique, ridges and grooves are more or less uniformly thick (2-2.5 μm).

Indian records: Naskar and Baksi 1978: 317, plate 1, figures 12-13, Akli Formation (Palaeocene-Eocene), near Kapurdi, Barmer District, Rajasthan.

Cicatricososporites sinuatus (Ramanujam 1967) Saxena, comb. nov.

Basionym: *Schizaeosporites sinuata* Ramanujam, Palynol. Bull. 2-3: 35-36, figure 30. 1967.

Description (Ramanujam 1967, p. 35-36): Spores brownish, monolete, lateral view plano-convex, proximal view oval, 50 x 37 μm (E_1 x P). Laesura narrow, long, faint, tenuimarginate. Exosporium 2.5 μm thick, surface longitudinally and slightly obliquely striated. Striae sinuate, sinuation being prominent locally. Ridges broader than grooves. Some portions of the grooves show the presence of more or less rounded, deeper areas, often with their own faint margins.

Indian records: Ramanujam 1967: 35-36, figure 30, Cuddalore Series (Miocene), South Arcot District, Tamil Nadu; Sarma and Ramanujam 1988: 144, figure

21, Neyveli lignite (Miocene), second lignite mine, Neyveli, South Arcot District, Tamil Nadu; Saxena and Khare 2004: 73, Late Palaeocene-Middle Eocene, Jayamkondacholapuram Well 12, Tiruchirapalli District, Tamil Nadu.

Cicatricososporites striatus (Baksi 1962) Saxena, comb. nov.

Basionym: *Monocolpopites striaei* Baksi, Bull. Geol. Min. Metall. Soc. India 26: 17, plate 2, figure 19. 1962.

Description (Baksi, 1962, p. 17): Equatorial compression; longer axis 46 μm ; surface characteristically ornamented with converging fine parallel striations; monocolpate, colpus narrow.

Indian records: Baksi 1962: 17, plate 2, figure 19, Tertiary, Simsang River Section, Shillong Plateau, Meghalaya.

Remarks: The photograph of this species clearly exhibits monolete mark.

Cicatricososporites suratensis (Samant & Tapaswi 2001) Saxena, comb. nov.

Basionym: *Schizaeosporites suratensis* Samant & Tapaswi, J. Palaeont. Soc. India 46: 123, plate 1, figure 3. 2001.

Description (Samant & Tapaswi 2001, p. 123): Spores oval, measuring 40-53 x 27-31 μm in size; monolete; laesura extend the length of the long axis, slightly crassimarginate, ends of laesurae pointed to blunt; exospore 2 μm thick; striate, striations parallel to each other and bifurcating, grooves about 2 μm wide, grooves and ridges of approximately the same width.

Indian records: Samant and Tapaswi 2001: 123, plate 1, figure 3, Surat lignite, Cambay Shale Formation (Early Eocene), Tarkeshwar, Surat District and Valia, Bharuch District, Gujarat.

OTHER RECORDS OF CICATRICOSOSPORITES

Other Indian records of *Cicatricososporites* (including those referred to *Schizaeosporites*), not assigned to any named species, are given below.

North-eastern India: Meghalaya: Sah and Dutta 1966: 75, plate 1, figure 13, Cherra Formation

(Palaeocene); Salujha et al. 1974: 273, plate 2, figure 25, Palaeogene; Tripathi and Singh 1985: 173, plate 3, figure 44, Therria Formation (Palaeocene); Kar and Singh 1986: 107, 108, plate 8, figures 3-4, 20, Jadukata and Mahadek formations (Late Cretaceous). **Assam:** Kumar 1994: 40, 84, 94, 101, plate 7, figure 8, plate 40, figures 6, plate 47, figure 8, plate 48, figures 6, 8, plate 49, figure 3, Jenam, Bokabil, Tipam and Dupitila formations (Middle Oligocene-Pliocene). **Tripura:** Kar 1990: 176, 182, plate 1, figure 20, Surma and Tipam groups (Miocene). **Arunachal Pradesh:** Prasad and Dey 1986: 69, Eocene, nala sections around Yinkiong and Dalbuing, East Siang District.

Western India: Kutch Basin, Gujarat: Sah and Kar 1969: 118, plate 2, figure 27, Laki Series (Early Eocene); Venkatachala et al. 1969: 195, plate 2, figure 36, Katrol Series (Late Jurassic); Kar 1978: 163, 166, plate 1, figure 14, Naredi and Harudi formations (Early-Middle Eocene); Kar 1985: 57, 68, 111, 119, plate 39, figure 4, Naredi and Harudi formations (Early-Middle Eocene); Kar and Bhattacharya 1992: 251, 257, plate 1, figure 26, Early Eocene. **Cambay Basin, Gujarat:** Mathur and Chowdhary 1977: 167, Kalol Formation (?Early Eocene); Koshal and Uniyal 1984: 240, plate 2, figure 1, Palaeocene-Early Eocene; Koshal and Uniyal (1986: 212, plate 1, figures 9-10, Palaeocene-Miocene. **Rajasthan:** Jain et al. 1973: 152-153, plate 1, figure 31, Barmer Sandstone (Palaeocene); Sah and Kar 1974: 164, plate 1, figure 6, Palana lignite (Early Eocene); Sharma 2000: 54, Late Palaeocene.

Northern India: Himachal Pradesh: Saxena and Bhattacharyya 1990: 110, plate 1, figure 9, Dharmasala Group (Oligocene-Early Miocene).

Southern India: Tamil Nadu: Venkatachala and Rawat 1972: 295, plate 1, figure 6, Palaeocene-Eocene; Sarma and Ramanujam 1988: 148, figure 16, Neyveli lignite (Miocene); Acharya 2000: 22, Early Eocene. **Andhra Pradesh:** Bose et al. 1982: 131, Gangapur Formation (Early Cretaceous). **Kerala:** Rao et al. 1993: 81, plate 1, figure 22, Early Miocene.

Bengal Fan, Indian Ocean: Chandra and Kumar 1998: 64-65, plate 2, figure 6, Late Tertiary, DSDP Leg 22, Site 218.

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