

STRATIGRAPHIC RANGE OF *DANDOTIASPORA* GEN. NOV. IN THE LOWER EOCENE SEDIMENTS OF INDIA

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ABSTRACT

A new generic name *Dandotiaspora* has been proposed for trilete spores varying from triangular to sub-circular in shape, with laevigate exine and having characteristic distal thickening associated directly with the trilete rays. The evolutionary tendency of the distal thickening within the genus has been discussed and on this basis five new species have been proposed. The stratigraphic value of these species within the Lower Eocene sediments of India has been brought forth.

INTRODUCTION

A perusal of published work on the Tertiary palynology of India reveals that pteridophytic spores have a long vertical distribution and wide geographical extent (VIMAL, 1952; BAKSI, 1962; BISWAS, 1962; GHOSH and BANERJEE, 1963; BANERJEE 1964, 1968; BOSE and SAH, 1964; MATHUR, 1966; SAH and DUTTA, 1966, 1968; SAH and KAR, 1969; GHOSH, 1969; VENKATACHALA and KAR, 1969 and others). It has also been observed that there are a few spore types which have a restricted vertical distribution, which when studied in detail may provide useful stratigraphic markers. Amongst these, a distinct type of trilete spore is conspicuous by its presence in most of the Lower Eocene sediments. The spores are characterized by a triangular to subcircular shape, psilate exine and distal thickening of exine along the trilete rays. Unfortunately the morphology of this group has so far not been fully understood and as a consequence this group of spore has been assigned by different workers to various genera and even morphographic types. In 1952, Vimal for the first time reported this type from the Dandot lignites (Lower Eocene), West Punjab, Pakistan. He described them as *Trilites* spm. 4, *Trilites* spm. 5, *Trilites* spm. 6, and *Trilites* spm. 7, taking into consideration the size, thickness of exine, nature and termination character of the trilete rays. Bose and Sah reported similar spores from the Laitryngew coalfield, Assam as? Cyatheaceous spore (1964, pl. 1, fig. 6). MATHUR (1966) also recorded similar type of spores from the Supra-Trappean beds of Kutch, Gujarat State, India. He assigned them to two genera viz. *Psilatriteles dilatatus* MATH. (1966, pl. 1, fig. 6) and *Foveotriteles psilatus* MATH. (1966, pl. 1, fig. 8). In the same year Sah and Dutta reported similar spores from the Cherra Sandstone Stage of Shillong Plateau. They, however, placed them under *Biretisporites* (Delc. & Sprum.) Delc., DETTM. & HUGH. (1963) instituting a new species viz. *Biretisporites triglobosus* SAH and DUTTA (1966, pl. 1, figs. 11-12). SAH and KAR (1969) while dealing with the pteridophytic spores from the Laki Series of Kutch, described some specimens, assignable to this group, as *Todisporites plicatus* SAH and KAR (1969, pl. 1, figs. 11-13). The latest record of similar type of spores is by Ghosh from Daranggiri and Rongrenggiri coals (Lower Eocene), Garo hills, Assam, who placed them under *Leiotriteles vimali* GHOSH (1969, pl. 2, fig. 48).

Recent investigations on the Palana lignites of Rajasthan and Tura formation of Assam

have shown abundant occurrence of this type of spores. This provided the present authors a unique opportunity of studying this sporomorph in greater detail. The authors have studied palynological fossils from measured sections ranging in age from the Katrols (Upper Jurassic) to Kirthar (Upper Eocene) in Kutch. The study revealed that this type of spore is restricted to the Lower Eocene sediments only. They have also systematically investigated spores and pollen grains from Lower Eocene to Pliocene sediments in Assam and observed that this type is here also similarly restricted to Lower Eocene sediments. Such a restricted vertical range of this characteristic spore type posed an important question whether this spore type could be reliably used as a marker fossil for delineating the Lower Eocene sediments of India. The characteristic distal thickening together with their presence in good percentage in assemblages from different areas also helped easy identification of this type. During the course of study it was further observed that this type had hitherto been placed by various authors under different genera. Furthermore it became evident that the thickening of the exine on the distal side is quite distinct from all genera to which it had been referred. Because of this characteristic thickening it became necessary to institute a new genus viz., *Dandotiaspora* to accommodate all such spores into a homogeneous complex so that they could be easily recognized and thus be used conveniently as guide fossils.

SYSTEMATIC PALYNOLOGY

Anteturma	..	..	..	<i>Sporites</i> H. POT., 1893
Turma	..	..	..	<i>Triletes</i> (Rein.) POT. & KR., 1954
Subturma	..	..	..	<i>Azonotriletes</i> LUB., 1935
Infraturma	..	..	..	<i>Laevigati</i> (BENNIE & KIDS.) POT., 1956

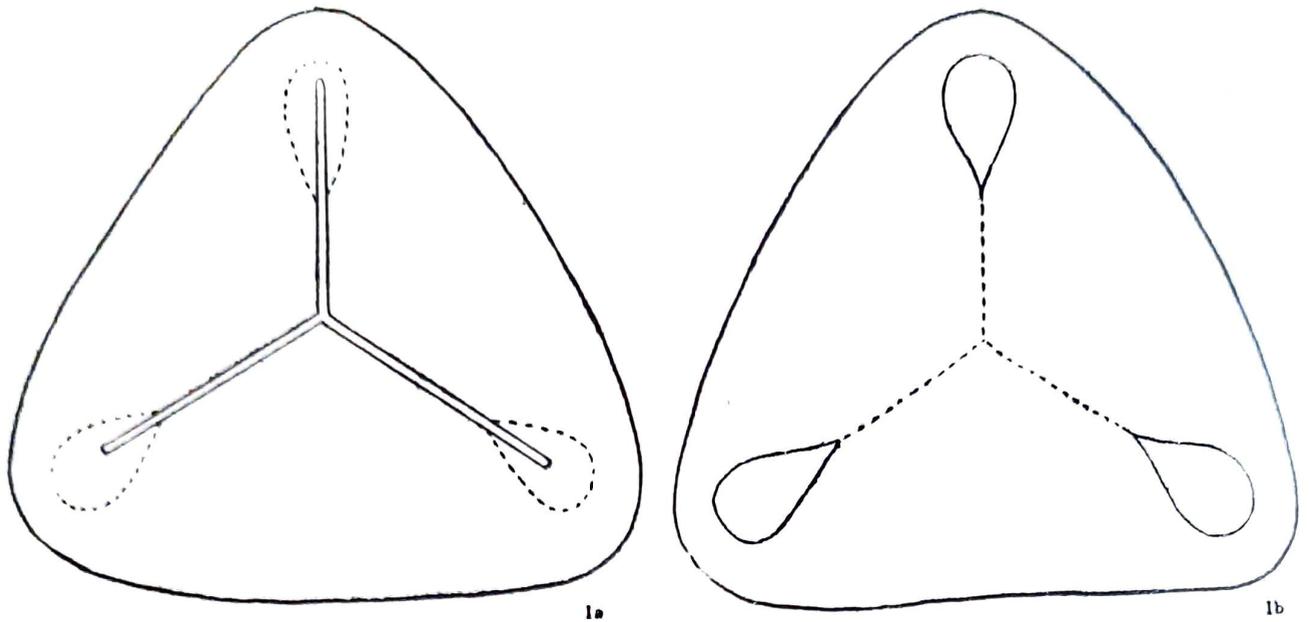
GENUS—***Dandotiaspora*** gen. nov.

TYPE SPECIES—*Dandotiaspora* (*Psilatrilletes*) *dilata* (Math.) comb. nov.

Generic Diagnosis—Spores triangular—subcircular in polar view. Trilete, rays extending half-equator. Exine laevigate, sometimes intrastriated, exine thickened on distal side in various ways opposite to haptotypic mark.

Description—Spores generally found in polar view, size range $40-102 \times 30-95 \mu$. Apices broadly rounded, interapical margins generally straight to convex. Trilete rays distinct in most specimens, rays equal or unequal, narrow, not appreciably raised, uniformly broad or slightly tapering at ends. Commissure well recognisable. Exine $1.5-4 \mu$ thick, sometimes more thickened at apices, mostly laevigate, sometimes intrapunctate, intrapunctate structure more concentrated at contact area, bactericide or fungicide generally attack spore coat in this area causing pseudoornamentational pattern. Exine on distal side regularly thickened opposite to trilete rays. In some specimens thickening appears only as a crescent in some ray ends, in others incipient thickening develops in association with rays providing false impression of raised trilete in low focus. When thickenings are well developed they look like warts or verrucae with or without continuation towards commissure, sometimes they are situated in apices to form pseudoauriculate structure. In some specimens an inner body is traceable, inner body may be incipient or well developed, sometimes it is recognisable in some parts while indistinguishable in rest (Text-fig. 1a-1b).

Comparison—*Biretisporites* (Delc. & Sprum.) DELC., DETTM. & HUGH. (1963) resembles the present genus in shape, size range and laevigate exine but the former is distinguished by its raised trilete rays. The trilete rays in *Dandotiaspora* is never appreciably raised though in low power the associated thickenings on the distal side may provide the appearance of



Text-figs. 1a & 1b. Showing organisation in *Dandotiaspora* gen. nov. 1a. Proximal view. 1b. Distal view.

raised trilete rays. *Cyathidites* COUP. (1953) resembles the present genus in general organization but is distinguished by the absence of thickened exine on the distal surface. *Dictyophyllidites* (COUP.) DETTM. (1963) outwardly resembles *Dandotiaspora* in thickening of the exine in contact area. This thickening is, however, due to the presence of a kyrptome which is very regular in its disposition. *Concavisporites* (Pfl.) DELG. & SPRUM. (1955) is also differentiated from the present genus by its well developed kyrptome. *Psilatriteles* v.d. HAM. (1954) is comparable to the present genus in size, shape and laevigate exine but is devoid of any regular thickening on the distal surface opposite to the contact area. *Todisporites* COUP. (1958) is subcircular—circular in shape and has no thickened exine on the distal surface. In some specimens of *Dandotiaspora* where distal thickened areas are shifted to apices they resemble very much to *Ahrensisporites* POT. & KR. (1955). It may be stated here that auriculate structure in *Ahrensisporites* is a very regular feature whereas in the present specimens it is just a chance or coincidence. *Trilobosporites* (Pant) ex POT. (1956) is also auriculate and sculptured with verrucae. *Dandotiaspora* instituted here is distinguished from all the known genera by its triangular—subcircular shape, laevigate exine and presence of distal thickenings on the exine opposite to the trilete rays.

Derivation of name—named after Dandot lignites, W. Punjab, West Pakistan from where this type of spores was first reported by VIMAL (1952).

Dandotiaspora* (*Psilatriteles*) *dilata (Math.) comb. nov.

(Pl. 1, Figs. 1-6, 19)

- 1952 .. *Trilites* spm. 6. VIMAL, p. 138, pl. 7, figs. 9-10.
- 1952 .. *Trilites* spm. 7. VIMAL, p. 138, pl. 7, fig. 11.
- 1964 .. ?*Cyatheaceous* spore BOSE & SAH, p. 220, pl. 1, fig. 6.
- 1966 .. *Psilatriteles dilatus* MATHUR, p. 38, pl. 1, fig. 6.
- 1966 .. *Biretisporites triglobosus* SAH & DUTTA, p. 74, pl. 1, figs. 11-12.

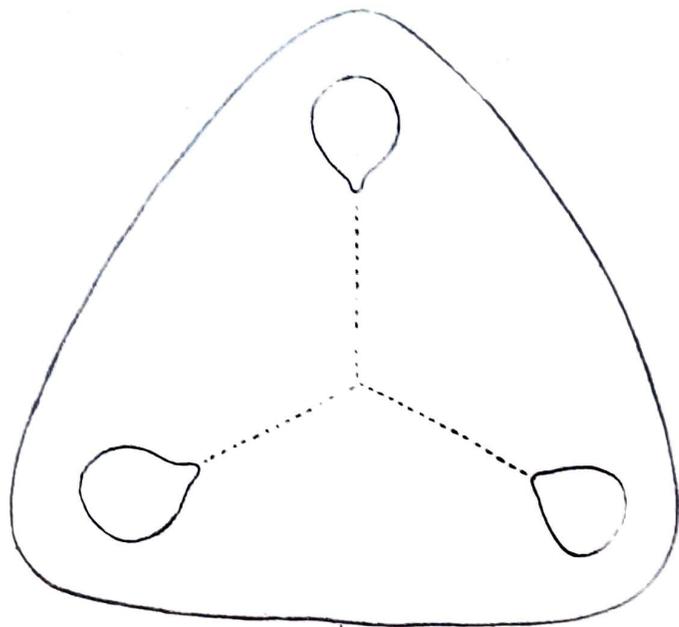
Holotype: MATHUR, 1966, pl. 1, fig. 6.

Isotype: SAH & DUTTA, 1966, pl. 1, fig. 11.

Type locality: Matanumadh, Supra-Trappean beds, Kutch, Gujarat State, India.

Diagnosis—Spores triangular—subtriangular in polar view, 56-98 μ . Trilete, rays upto three-fourth radius. Exine laevigate, sometimes intrapunctate, exine roundly thickened on distal side opposite to ray ends.

Description—Spores generally subtriangular with rounded apices and straight—convex interapical margins. Trilete rays narrow, not much elevated, equal or unequal, uniformly broad or slightly tapering at ends, commissure distinct. Exine 2-3.5 μ thick, in some specimens more thickened at apices, intrapunctate structure while present more pronounced at inter-radial areas. Distally exine thickened to form globular heads opposite to ray ends, in some specimens they are quite high and appear as warts or verrucae (Text-fig. 2).



Text-fig. 2. Showing organisation in *Dandotiaspora dilata*.

Occurrence—Dandot lignites, W. Punjab, Pakistan; Laitryngew coalfield, Assam; Daranggiri and Rongrenggiri coalfields, Assam; Tura formation, Assam; Spura-Trappean beds, Kutch, Gujarat.

***Dandotiaspora (Todisporites) plicata* (SAH & KAR) comb. nov.**

(Pl. 1., Fig. 7)

1969—*Todisporites plicatus* SAH & KAR, p. 112, pl. 1, figs. 11-13.

Holotype: SAH & KAR, 1969, pl. 1, fig. 11.

Type locality: Bore-core no. 15, Laki Series, Kutch, Gujarat State, India.

Diagnosis—Spores triangular—subtriangular in polar view, 45—75 μ . Trilete, rays extending half to three-fourth radius. Exine 1.4—3 μ thick, laevigate, sometimes intrastuctured at contact area, may be more thickened at apices, exine on distal surface forms crescent shaped thickening at ray ends, sometimes they are hardly perceptible (Text-fig. 3).

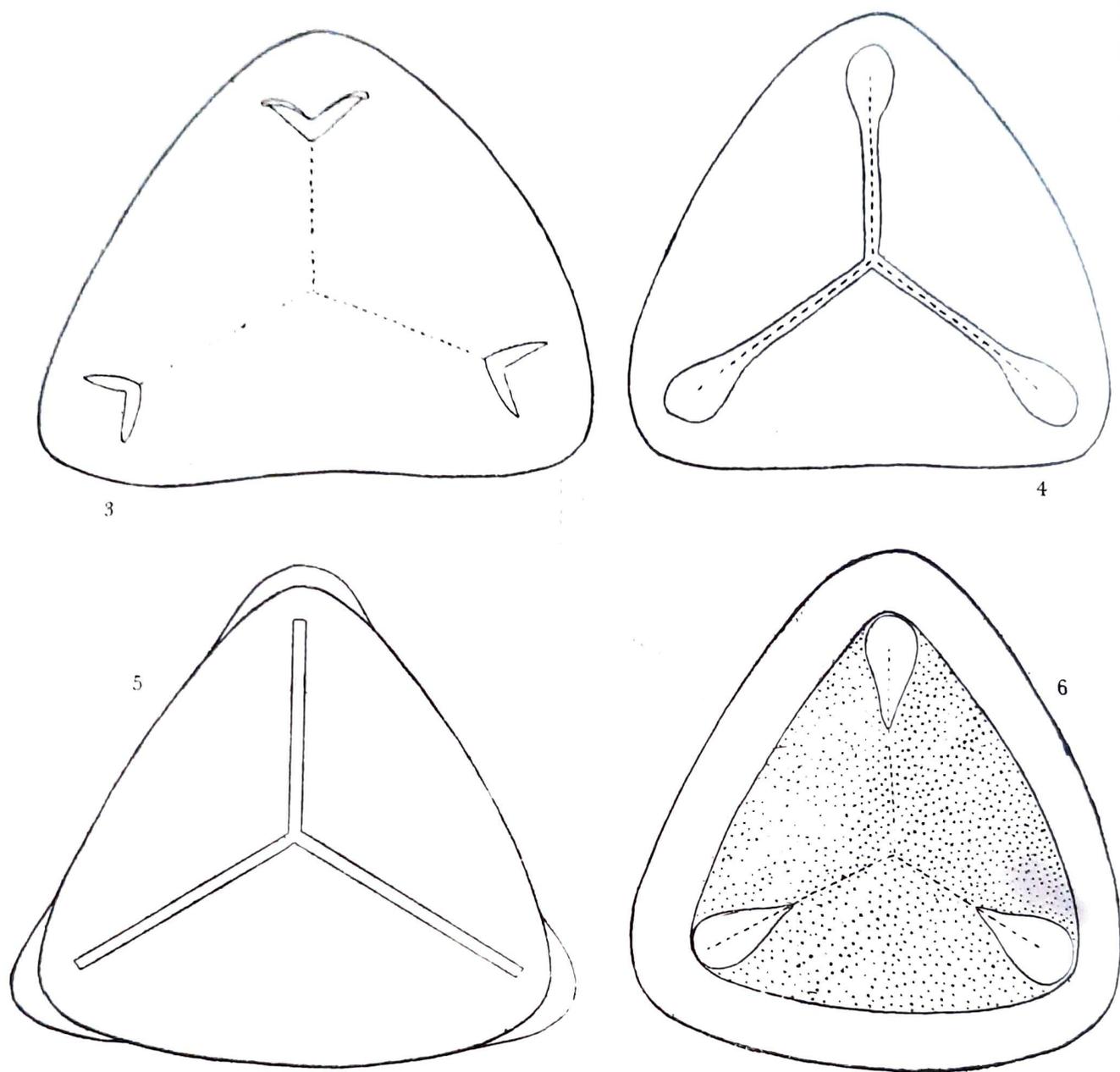
Comparison—*Dandotiaspora dilata* (Math.) comb. nov. resembles the present species in shape and laevigate exine, the former is, however, distinguished by its very well developed globular thickenings on the distal side opposite to the ray ends. Moreover, *D. dilata* has a much bigger size range than *D. plicata*.

Occurrence—Laki Series, Kutch; Tura formation, Assam.

***Dandotiaspora telonata* sp. nov.**

(Pl. 1, Figs. 8-13)

1952: *Trilites* spm. 5. VIMAL, p. 138, pl. 7, figs. 7-8.



Text-figs. 3-6. Showing organisation of spores. 3. *Dandotiaspora plicata*; 4. *D. telonata*, 5. *D. pseudoauriculata*; 6. *D. densicarpa*

Holotype: Pl. 1, Fig. 8. Size 64 μ , Slide no. 3665.

Type locality: Damalgiri, Garo hills, Assam.

Diagnosis—Spores triangular—subtriangular in polar view, 56-87 μ . Trilete, rays extending upto three-fourth radius. Exine 2—3.5 μ thick, sometimes more thickened at apices, laevigate, sometimes intrapunctate at interradial areas, exine distally thickened opposite to trilete rays throughout, sometimes bifurcating or producing globular heads at ray ends (Text.-fig. 4).

Comparison—*Dandotiaspora dilata* (Math.) comb. nov. closely resembles the present species in size range and shape but is distinguished by the presence of globular heads only opposite to ray ends. *D. plicata* (SAH & KAR) comb. nov. has only crescent like thickenings at ray ends. In the present species the distal thickening is throughout the length of the trilete rays.

Remarks—*Foveotriletes psilatus* MATH. (1966) also seems to belong to this species.

Occurrence—Dandot lignites, W. Punjab, Pakistan; Supra-Trappean beds, Kutch; Tura formation, Assam; Palana lignites, Rajasthan.

***Dandotiaspora pseudoauriculata* sp. nov.**

(Pl. 1, Figs. 14-16)

Holotype: Pl. 1, Fig. 14. Size 66 μ , Slide No. 3661.

Type locality: Damalgiri, Garo hills, Assam.

Diagnosis—Spores triangular—subtriangular in polar view, 49—86 μ . Trilete, rays upto three-fourth radius. Exine laevigate, 2-4 μ thick, sometimes intrapunctate, puncta more prominent in contact area, distally exine more prominent in contact area, distally exine thickened opposite to ray ends, thickenings extend at apices to form pseudoauriculate structure (Text-fig. 5).

Comparison—*Dandotiaspora dilata* (Math.) comb. nov. closely resembles the present species in shape, size range and thickenings of the distal exine only at ray ends, the present species is, however, distinguished by its presence of thickening only at the apices to form a pseudoauriculate appearance. *D. telonata* has thickening of the distal exine throughout the length of the trilete rays whereas in *D. plicata* (SAH & KAR) comb. nov. they are crescent shaped and restricted at ray ends.

Remarks—In some specimens bacteriacide or fungicide severely attacked the spore coat and as a result the proximal or distal surface is fully eaten away except the thickening at the apices. This pathogenic condition also attributes to the formation of pseudoornamentation at the surface.

Occurrence—Dandot lignites, W. Punjab, Pakistan; Tura formation, Assam.

***Dandotiaspora densicorpa* sp. nov.**

(Pl. 1, Figs. 17-18)

Holotype: Pl. 1, Fig. 17, Size 66 μ . Slide no. 3663.

Type locality: Nongwalbibra, Garo hills, Assam.

Diagnosis—Spores triangular—subcircular in polar view, 56-89 μ . Trilete, rays extending half to three-fourth radius. Exine 1.5—3 μ thick, laevigate, sometimes intrapunctate, puncta more concentrated in interradial areas, exine distally thickened opposite to ray ends. Inner body present, generally well recognizable, dense at outer region, sometimes, incipient and traceable only in some parts (Text-fig. 6).

Comparison—*Dandotiaspora dilata* (Math.) comb. nov. approximates the present species in shape, size range and nature of the distal thickening but has no inner body. *D. densicorpa* instituted here is readily separated from all the known species of the genus by its presence of perceptible inner body.

Occurrence—Tura formation, Assam.

DISCUSSION

Morphological variations

The genus *Dandotiaspora* seems to be a morphologically distinct spore type possessing a distal thickening in association with the trilete rays. Although some genera e.g. *Dictyophylidites* (Coup.) DETTM. (1963) and *Concavisporites* (PIL.) DELG. & SPRUM. (1955) are characterized by a thickening along the contact area in the form of a 'kyrtome', the nature of the thickening met with in *Dandotiaspora* seems quite different. In the latter it is not so restricted

as is seen in the two former genera and may be present anywhere from the commissure to the apices. The transitional stages of the thickening studied in a large number of specimens indicate developmental tendencies within the genus.

Morphologic and biometric analyses of specimens studied from different sedimentary basins clearly distinguish five species which have been described earlier. The various trends of specialization in the distal thickening is reflected within these species as they are morphologically distinct only when considered as end products. The following sequential changes are envisaged to have taken place in this group:

1. Appearance of a small, dense, crescent shaped fold at the ray ends, as is seen in *Dandotiaspora plicata* (SAH & KAR) comb. nov.
2. *Dandotiaspora dilata* (MATH.) comb. nov. in all probability represents the next stage of development. It is easy to visualize the transformation of a globular thickening at the ray ends through an extension of the crescent shaped thickening.
3. The third stage of advancement can be followed through the development of the globular distal thickening at the ray ends and their subsequent extension towards or upto the commissure. The specimens assignable to *Dandotiaspora telonata* typifies this condition.
4. Distal thickening confined to the apices and presenting a pseudoauriculate appearance seems to mark another stage in the development. This condition reflects the shifting of the thickening from the ray ends towards the periphery. It is clearly discernible in spores referred to *Dandotiaspora pseudoauriculata*.
5. The specimens referable to *Dandotiaspora densicorpa* are characterized by a dense inner thickening along the interradial areas and ray ends. These probably represent the most advanced stage of development of the thickening.

Stratigraphic significance

Although a great deal of detailed work is still necessary before individual taxon could be used with any precision as zone fossil in the Tertiary sediments of India, the present study, however, indicates that Tertiary assemblages do possess individual characteristic elements which can serve as potential stratigraphic markers. The main object of this study has been to ascertain the stratigraphic limits of *Dandotiaspora* in the Tertiary succession of India. Five species of this genus recorded here have a restricted vertical range in the Tertiary sediments of Assam. Extended investigations in other Tertiary sedimentary basin of India have clearly demonstrated the lateral presistence of this easily recognizable taxon with limited vertical range.

From Text-fig. 7, which gives the stratigraphic distribution of this genus, it becomes apparent that the vertical range of all the species is mainly restricted to the Lower Eocene sediments. That none of them range beyond Lower Eocene is evident from the study of several measured sections from Garo, Khasi and Jaintia hills of Assam. *Dandotiaspora dilata* forms a dominant element in Cherra and Tura formations of Western Assam. In Shillong Plateau this species continues to be dominant in the overlying Lakadong stage of Sylhet Limestone formation but is absent in the upper stages of the Sylhet Limestone formation and the overlying Kopili formation. Its vertical range in the Tura formation of Garo hills is restricted to the basal beds only, which are Palaeocene in age. The remaining four species are found in lower frequencies in Cherra formation of Shillong Plateau but are quite abundant in the basal zones of the Tura formation. *Dandotiaspora dilata*, *D. telonata* and *D. plicata* are fairly well represented in the Laki sediments of Kutch while the remaining two species

KNOWN STRATIGRAPHIC DISTRIBUTION OF DANDOTIASPORA GEN. NOV. IN THE LOWER EOCENE SEDIMENTS OF INDIA

AREAS		ASSAM						GUJARAT		RAJASTHAN	WEST PAKISTAN
		SHILONG PLATEAU		GARO HILLS		MADH FORMATION	KAKDI FORMATION	PALANA SUBCROPS	DANDOT LIGNITE		
TAXON	FORMATION	LANGPAR FORMATION	CHERRA FORMATION	LAKADONG FORMATION	TURA FORMATION	PALAEOCENE LOWER EOCENE	PALAEOCENE LOWER EOCENE	PALAEOCENE LOWER EOCENE	PALANA SUBCROPS	DANDOT LIGNITE	
	AGE	DANIAN	PALAEOCENE	LOWER EOCENE	PALAEOCENE LOWER EOCENE	PALAEOCENE LOWER EOCENE	PALAEOCENE LOWER EOCENE	PALAEOCENE LOWER EOCENE	LOWER EOCENE	LOWER EOCENE	
DANDOTIASPORA DILATA (MATHUR) COMB NOV		---	---	---	---	---	---	---	---	---	
DANDOTIASPORA TELONATA SP NOV		?	---	---	---	---	---	---	---	---	
DANDOTIASPORA PLICATA (SAH & KAR) COMB NOV		---	---	---	---	---	---	---	---	---	
DANDOTIASPORA PSEUDOauriculata SP NOV		?	---	---	---	---	---	---	---	---	
DANDOTIASPORA DENSICORPA SP NOV		---	?	---	---	---	---	---	---	---	

PERCENTAGE



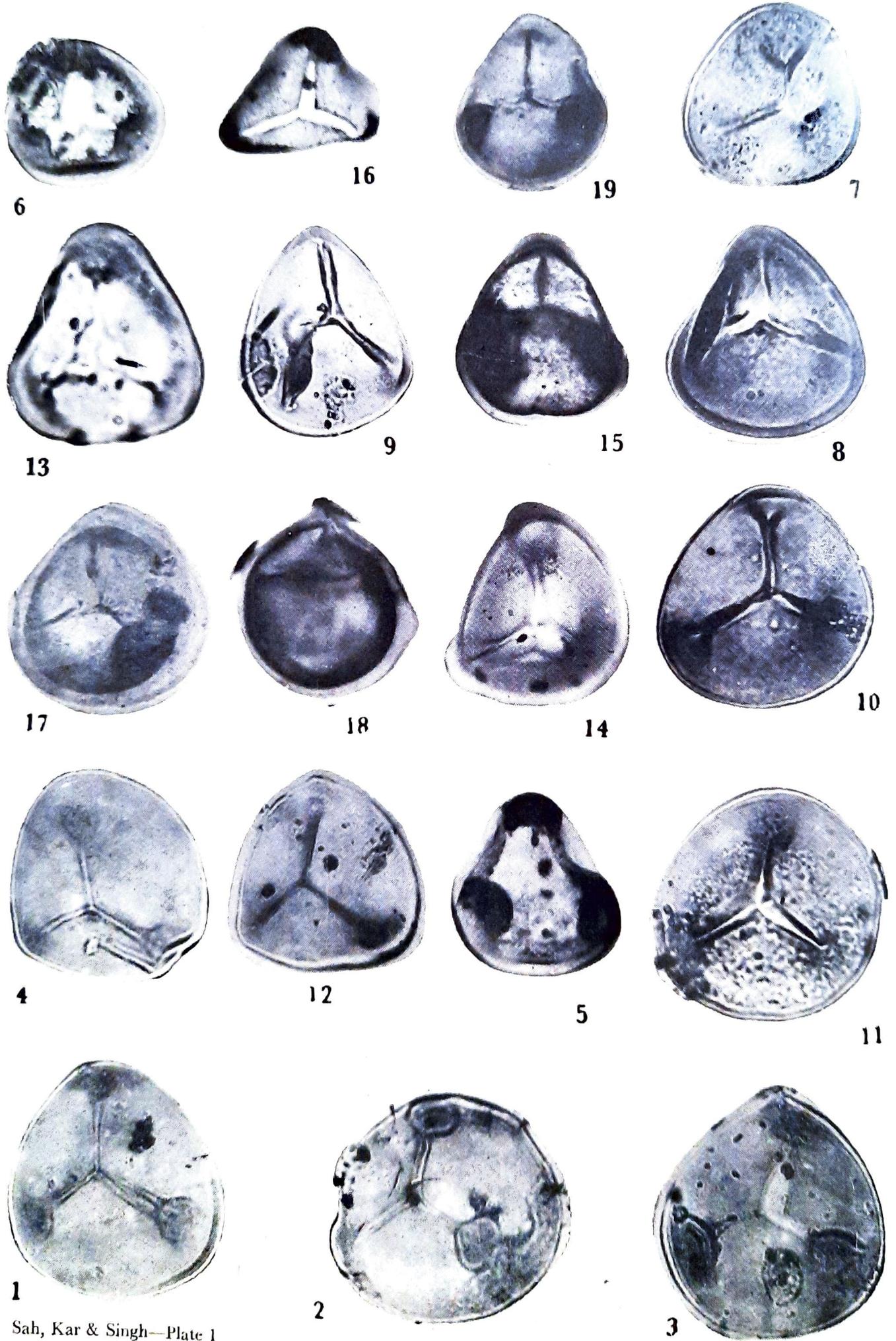
Text-fig. 7. Showing stratigraphic distribution of *Dandotiaspora* gen. nov. in the Lower Eocene sediments of India.

are poorly represented. Examination of samples from 30 bore-holes and a number of measured sections from the Tertiary sediments of Kutch show that the genus *Dandotiaspora* is not represented in Middle Eocene and younger sediments. Three sections from Rajasthan shell indicate a good representation of *D. telonata* and presence in lower frequencies of the remaining four species. The samples examined come from horizons which are at present regarded to be Palaeocene to Lower Eocene in age. Since sediments from horizons younger than Lower Eocene and older than Palaeocene have not yielded any palynological fossils the exact vertical range of *Dandotiaspora* in Rajasthan shelf cannot be commented upon at the present moment.

Evidence pertaining towards the downward extension of *Dandotiaspora* into the Cretaceous sediments of India is meagre. There is no published record of a Upper Cretaceous palynological assemblage from Kutch or Rajasthan. The Middle to Upper Cretaceous (Aptian-Albian) assemblage from east coast of India described by BANERJEE and MISRA (1968, pp. 102-103, pls. 1-4) does not include a single spore type referable to *Dandotiaspora*. However, a few samples from the Langpar Stage (Danian) of Therriaghat, Shillong Plateau (still under study) examined by the authors show the presence of a few spores of *Dandotiaspora plicata* and *D. dilata*. It means that the genus appeared for the first time during the Danian or Maestrichtian, developed progressively during the Early Palaeocene, reached its maxima during the Upper Palaeocene and Lower Eocene (Ypresian-Lutetian) and finally dwindled during the Middle-Upper Eocene.

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EXPLANATION OF PLATE I

(All photomicrographs are ca. x 500)

- 1-6, 19. *Dandotiaspora dilata* (Math.) comb. nov. Slide nos. 3655, 3656, 3658, 3659, 3660, 3664.
7. *Dandotiaspora plicata* (SAH & KAR) comb. nov. Slide no. 3667.
- 8-13. *Dandotiaspora telonata* sp. nov.
Slide nos. 3665, 3655, 3656, 3654, 3657, 3666.
- 14-16. *Dandotiaspora pseudoauriculata* sp. nov.
Slide nos. 3661, 3661, 3662.
- 17-18. *Dandotiaspora densicorpa* sp. nov.
Slide nos. 3663, 3664.