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MORPHOGRAPHIC STUDY OF SOME DISPERSED TRILETE MIOSPORES (SUB-INFRATURMA-VARITRILETI) FROM THE LOWER GONDWANA OF INDIA

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ABSTRACT

The sub-infraturma Varitrileti includes such trilete miospores which exhibit differential distribution of ornament as well as characteristic folds associated with the trilete rays. In the course of time, a number of genera were accommodated in this group and their stratigraphic significance was also indicated. The present investigation suggests that six genera could be delimited in this group, viz., *Microbaculispora*, *Microfoveolatispora*, *Didecitriletes*, *Lacinitriletes*, *Brevitriletes*, and *Imparitriletes* gen. nov. In the present work, attempts have been made to circumscribe the species of each genus on the basis of quantitative characters determined statistically after studying a number of specimens as well as the types. In all, 19 species have been recognized and described in detail. The distribution pattern of the species in each genus of this group has been ascertained on the basis of quantitative analysis of some well-dated sequences which collectively represent the Lower Gondwana formations.

Key-words — Palynology, Trilete miospores, Varitrileti, Lower Gondwana (India).

साराँश

भारत के अधर गोंडवाना से कुछ परिक्षेपित त्रिअरीय मिओबीजाणुओं (उप-इन्फ्राटुर्मा-वेरिट्राइलिटी) का आकृतिक अध्ययन – राम शंकर तिवारी एवं विजया सिंह

उप-इन्फ्राटुर्मा वेरिट्राइलिटी में वे त्रिअरीय मिओबीजाणु आते हैं जो अलंकरणों के अन्तरात्मक वितरण एवं त्रिअरीय अरों से संबद्ध लाक्षणिक मोड़ों को प्रदर्शित करते हैं। अभी तक इस समूह में बहुत से वंश समायोजित किये गये तथा उनका स्तरिक महत्त्व भी प्रदर्शित किया गया। वर्तमान अध्ययन इंगित करता है कि इस समूह में वंश अर्थात् **माइक्रोबेक्युलिस्पोरा, माइक्रोफ़ोवियोलेटिस्पोरा, डाइडेसिट्राइलिटीज़, लेसिनिट्राइलिटीज़, ब्रेविट्राइलिटीज़** तथा **इम्पेरिट्राइलिटीज** नव वंश परिसीमित किये जा सकते हैं। इस शोध में बहुत से प्रादर्शों एवं प्रारूपों के साँख्यिकीयतः निर्धारित परिमाणात्मक लक्षणों के आधार पर प्रत्येक वंश की जातियों को परिसीमित करने के प्रयास किये गये हैं। कुल मिलाकर 19 जातियाँ अभिनिर्धारित एवं विस्तारपूर्वक वर्णित की गई हैं। अधर गोंडवाना शैल-समूहों को निरूपित करने वाले कुछ सुनिर्धारित अनुक्रमों के परिमाणात्मक विश्लेषण के आधार पर इस समूह के प्रत्येक वंश की जातियों के वितरण का ढंग निश्चित किया गया है।

INTRODUCTION

THE nature of trilete mark present in the genera *Leiotriletes*, *Calamospora* and *Lophotriletes* is basically different from what has been observed in *Microbaculispora*, *Microfoveolatispora*, *Didecitriletes* and *Lacinitriletes* (Bharadwaj, 1962; Venkatachala & Kar, 1965). In the latter genera, the trilete rays are associated with regular, thick folds, and the sculpture is present only on the distal and proximo-equatorial regions. Spores having similar organisation have also been reported from Australian Lower Gondwana sediments by Balme and Hennelly (1956), Segroves (1970) and Foster (1979). The recognition of the prevalence of such features, i.e. germinal apertures associated with folds and differential ornament on the polar faces, led Venkatachala and Kar (1965) to create a new sub-infraturma, i.e. Varitrileti.

So far, little work has been done on the Varitrileti-group which mostly has a restricted distribution to the Lower Gondwana horizons. The present study determines the

morphographical circumscription of various genera and species of this group and establishes the distributional pattern of different species through the Lower Gondwana formations of India.

MATERIAL AND METHODS

The material for the present study has been procured from several coalfields (Table 1), represented in Map 1 by their respective index numbers. It includes bore-core, outcrop and colliery samples, and some of the type slides. The requisite material was accumulated during the past several years at the Department of Coal Palaeobotany, Birbal Sahni Institute of Palaeobotany, and most of it has been already analysed for general palynology or correlation.

For the determination of quantitative representation of this group at specific level, two hundred specimens were counted from each sample. The quantitatively analysed stratigraphical successions are given in Table 2.

TAXONOMIC STATUS OF VARITRILETI

The Varitrileti-group includes the genera *Microbaculispora*, *Microfoveolatispora*, *Didecitriletes*, *Lacinitriletes*, *Brevitriletes* and *Imparitriletes*. Among these, the genera *Microbaculispora* and *Microfoveolatispora* were kept by Bharadwaj (1962) under infraturma Apiculati and Murornati respectively because at that time, no significance was attached to the association of folds along the trilete mark. In 1965, Venkatachala and Kar classified all such genera under a new sub-infraturma — Varitrileti, under infraturma — Apiculati in the Potonié's system of classification. However, Bharadwaj (1974, 1975) classified such spores under the infraturma-Longipolaxi.

SYSTEMATIC DESCRIPTION

In the following account, the terms used for denoting relative abundance of different taxa are: dominant —26%-75%; abundant —11%-25%; common —1·1%-10%; rare —0·1%-1·0%. Besides, in the quantitative analysis the terms 'inconsistent' denotes occurrence of species only in one or more samples but not in all the samples; 'in traces' indicates only the presence of a species not found in countings but marked while scanning a number of slides.

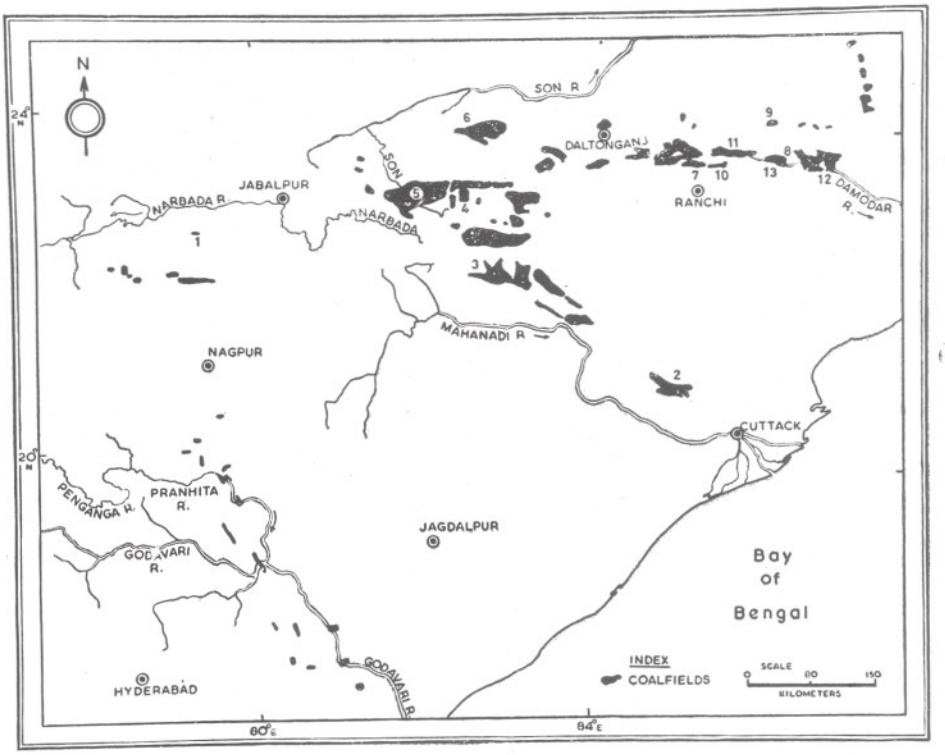
Genus — *Microbaculispora* Bharadwaj, 1962

Type Species — *Microbaculispora gondwanensis* Bharadwaj, 1962.

Remarks — In general, the present observations on the morphographic characters of a large population of the genus *Microbaculispora* are corroborative of those described by Bharadwaj (1962) for this genus. The presence of folds along the trilete rays is a constant character. However, in the ornament-processess, earlier described as bacula, two kinds have been noticed. One type consists of rod-like processes of constant width with straight sides (Text-fig. 3A, D, E) while the other has bacula

TABLE 1

Coalfield	Index No. in Map 1	Reference for material
1. Mohpani Coalfield	1	Bharadwaj & Anand-Prakash, 1972b
2. Talchir Coalfield	2	Srivastava, 1969b
3. Korba Coalfield	3	Bharadwaj & Srivastava, 1973
4. Chirimiri Coalfield	4	Bharadwaj & Srivastava, 1969b
5. Sohagpur Coalfield	5	Bharadwaj & Srivastava, 1971
6. Singrauli Coalfield	6	Bharadwaj & Sinha, 1969b
7. South Karanpura Coalfield	7	Dwivedi, 1976
8. Raniganj Coalfield	8	Tiwari, 1973
9. Giridih Coalfield	9	Srivastava, 1973b
10. Ramgarh Coalfield	10	Srivastava (Ms.)
11. West Bokaro Coalfield	11	Tiwari, 1965
12. Raniganj Coalfield	12	Bharadwaj, 1962
13. Jharia Coalfield	13	Bharadwaj, Sah & Tiwari, 1965



MAP 1 — A portion of Peninsular India showing different Lower Gondwana coalfields (after Fox, 1934).

TABLE 2

FORMATION	LOCATION	SAMPLES	REFERENCE
1. Raniganj	Dishergarh area Raniganj Coalfield	Bore hole NCRD-2, 1-18	Tiwari, 1976
2. Upper Barakar	Pusai-Shampur area West of Barakar River in Raniganj Coalfield	47+67d, 67e, 68, 71, 72, 75, 77, 78a, 78b, 81	Tiwari, 1973
3. Middle Barakar	-do-	39a+b, 40, 42, 45, 46/3+46/4	-do-
4. Lower Barakar	-do-	10+11, 12+12a, Ch-1 to Ch-10, 36a+b, 37c	-do-
5. Upper Karharbari	Korba Coalfield	Bore hole NCKB-19, Samples 134-145	Bharadwaj & Srivastava, 1973
6. Lower Karharbari	-do-	Bore hole NCKB-19, Samples 117A.132	-do-
7. Talchir	-do-	Bore hole NCKB-19, Samples 101-114	-do-

(Text-fig. 3C) of variable width and constricted in the middle.

Recently, Anderson (1977) has given very broad-based circumscriptions of *Sporae dispersae*. He has not attached any importance to the qualitative differences in the ornament of trilete spores and this has resulted in the lumping together of distinct

lines of morphographic characters. The genus *Microbaculispora* as defined by Anderson (1977) evidently includes laevigate, granulate, gemmate, verrucate, papillate, conate, spinate, foveolate, punctate, vermiculate, and reticulate forms which otherwise qualify for a number of different taxa of the trilete spores. Such an approach is not acceptable to us as it may adversely affect finer and precise palynostratigraphy.

Systematics

Microbaculispora gondwanensis Bharadwaj, 1962 — Size range 70-90 μm, various axes usually unequal. Bacula 1 μm broad, 1·5-2 μm long.

M. villosa (Balme & Hennelly) Bharadwaj, 1962 — Size range 68-98 μm; various axes usually unequal. Exine 1 μm thick. Bacula 1 μm broad, 3-4 μm long.

M. barakarensis Tiwari, 1965 — Size range 75-83 μm. Exine 1·5-2 μm thick. Bacula closely set, 2-2·5 μm broad, 1-1·5 μm high, head truncate, 70-90 on the margin.

M. indica Tiwari, 1965 — Size range 44-72 μm. Exine 1·5-2 μm thick. Bacula closely set, ±1 μm high, 1-1·5 μm broad, head round, 55-75 on the margin.

M. tentula Tiwari, 1965 — Size range 37-56 μm. Exine ±1 μm thick. Bacula closely set, 1×1 μm.

M. minuta Venkatachala & Kar, 1968a — Size range 36-46 μm. Exine ±1 μm thick. Bacula 0·5-1 μm wide and equally long.

M. variata Tiwari & Navale, 1967 — Size range 48-68 μm. Bacula closely set, 2-4 μm wide, 3-6 μm long, finger-shaped with blunt or rounded apices. Proximal median region smooth or finely granulose.

M. novica Gupta & Boozer, 1969 — Size range 41-48 μm. Bacula closely set, 2·3 μm high.

M. novicus is corrected here as *M. novica.*

Morphography and Specific Delimitation

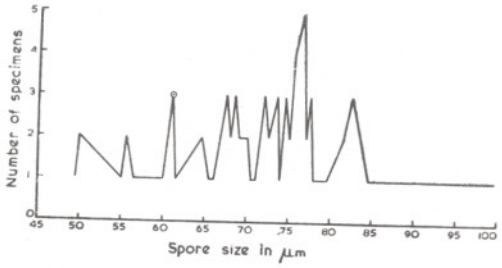
Miospores are triangular in shape in polar view with straight to slightly convex inter-apical margins and rounded apices. In such specimens, the various equatorial axes are almost equal in length. In meridional plane the specimens look spindle-like or carrot-like with broad proximal face and angular distal face (Bharadwaj, 1962, text-fig. 4B). Here the two axes vary in their lengths with respect to each other.

The size range of the specimens in polar view of the species studied presently, and also by Bharadwaj (1962) is 30-98 μm. The trilete mark is distinct and the sutures are straight, their lengths varying even in the same specimen. Each suture is accompanied by folds on its both sides. Sometimes the fold may be absent along with any one of the three trilete rays. This obviously is the result of abnormal flattening of the specimen. Usually the folds attain their maximum width in the middle of the ray and attenuate towards the ray-ends. Exine is 1-3 μm thick in optical section excluding the equatorial ornamentation. In distribution, the bacula are restricted to the distal and proximo-equatorial region of the spore body, being absent from the inter-ray areas. Within the genus, the size and nature of the bacula vary characteristically. Each baculum on the *extrema lineamenta* is a straight rod or slightly curved in the middle with flat or truncate top. The known dimensions of the bacula are 1-6 μm in length and 1-4 μm in width. In surface view, the bacula are circular to polygonal in shape, almost evenly spaced and 1-4 μm in diameter. In deep focus, they exhibit a reticulate pattern.

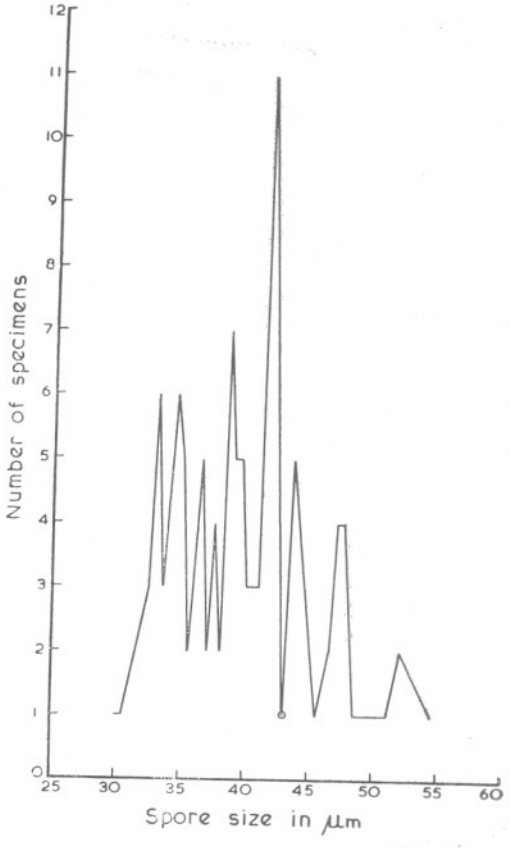
In meridionally flattened specimens, the trilete mark is partly in view. A median vertical fold is usually seen in such laterally flattened specimens which, obviously, is formed to accommodate the conical-cylindrical dimension of the spore (Bharadwaj, 1962, text-fig. 4A, B).

The two species which have been studied in detail here are *Microbaculispora indica* Tiwari (1965) and *M. tentula* Tiwari (1965). In order to know the extent to homogeneity in the population included in a species on the basis of spore size, when other morphographic characters are similar, frequency curves have been plotted for each species. The details of these curves are as follows:

In the frequency curve (Text-fig. 1) for *M. indica*, the overall size of the specimens has been plotted against the number of specimens. The spore size considered is the mean value for each specimen excluding the equatorial ornamentations. The size-range is 48-100 μm. The curve thus obtained



TEXT-FIG. 1 — Frequency curve showing relationship of overall spore size in μm and number of specimens in *Microbaculispora indica* Tiwari (1965) emend.



TEXT-FIG. 2 — Frequency curve showing relationship of overall spore size in μm and number of specimens in *Microbaculispora tentula* Tiwari, 1965.

is a normal curve attaining its maximum at 76·5 μm which reveals the presence of a single taxonomic entity in this population. As all the specimens included in this species are similar in other morphographic characters, there is no possibility of subgrouping within this assemblage. Therefore, this size range, i.e. 49-100 μm has been referred to a single specific unit — *M. indica* Tiwari, (1965).

In *M. tentula*, the recorded size-range is 30-55 μm. The frequency curve (Text-fig. 2) attains its maximum at 41·5 μm with almost equal number of observations on its both sides deciphering the existence of a single group in the miospore population. On the basis of this analysis, the size limits of the specimens in both species have been enlarged over what has been described originally by Tiwari (1965). Hence, the corrected size-range for *M. indica* and *M. tentula* is 44-100 μm and 30-56 μm respectively.

From the study of a large number of specimens as well as critical assessment of the available published record, following species remain distinguishable in the genus *Microbaculispora*:

M. gondwanensis Bharadwaj, 1962
M. villosa (Balme & Hennelly, 1956) Bharadwaj, 1962
M. barakarensis Tiwari, 1965
M. indica Tiwari, 1965
M. tentula Tiwari, 1965
M. variata Tiwari & Navale, 1967
M. novica Gupta & Boozer, 1969

Microbaculispora indica Tiwari (1965) emend.

Pl. 1, figs 1-6; Pl. 2, fig. 17

Lectotype — Tiwari, 1965, pl. 2, fig. 33, size 61 μm.

Emended Diagnosis — Triangular to subtrangular. Trilete mark distinct. Exine 1-2 μm thick, distally ornamented with ± 1 μm high and 1·5-2 μm broad bacula with flat or round heads, bacula closely set on *extrema lineamenta* as well as on distal and equatorial regions.

Size Range — 44-100 μm (Text-fig. 1).

Most of the specimens (studied 85) are triangular with ± straight sides and broadly or acutely rounded angles, sometimes subtriangular with rounded angles due to lateral flattening (Pl. 1, figs 1, 4). Trilete rays are equal in length attenuating towards the equator (Pl. 1, fig. 1). The trilete rays may end slightly before the equator. Usually all the three rays are associated

with thick folds (Pl. 1, fig. 4). Exine in optical section measures 1-2 μm (Pl. 1, figs 1, 4). The width of the bacula is more than its height and the apex is usually flat or roundly flat (Text-fig. 3D). In order to know the nature and distribution of bacula, some of the specimens have been photographed in the differential interference contrast (Pl. 1, figs 2, 5). On *extrema lineamenta* the bacula are very close to each other. In surface view the size of bacula is variable and they appear as polygonal areas measuring 1-3 μm in diameter bound by a negative reticulum (Pl. 1, fig. 6).

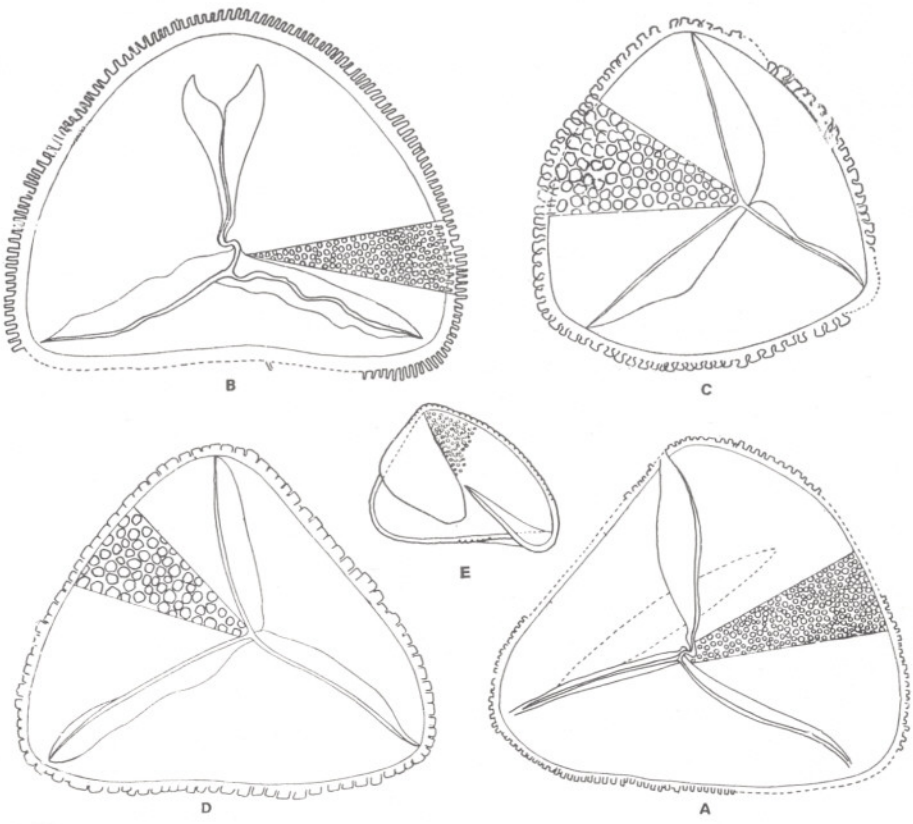
Remarks — During the present study, variations have been observed in overall spore size, exine thickness and in the size of the bacula which do not correspond with those given by Tiwari (1965) and therefore the diagnosis has been emended. The species is recognizable by its characteristic size and 1 μm high, 1·5 to 2 μm wide bacula with more of less straight sides and flat or rounded heads.

Microbaculispora tentula Tiwari, 1965

Pl. 2, figs 14-16; Pl. 3, figs 22, 26, 27

Holotype — Tiwari, 1965, pl. 2, fig. 35, size 43 μm.

Size Range — 30-56 μm (Text-fig. 2).



TEXT-FIG. 3A-E — **A.** *Microbaculispora gondwanensis* Bharadwaj, 1962 (Holotype). Nature of trilete mark, proximal view; a sector showing sculptural elements on distal face and *extrema lineamenta*. ca × 755. **B.** *M. villosa* (B. & H.) Bharadwaj, 1962. Nature of trilete mark, proximal view; a sector showing sculptural elements on distal face and *extrema lineamenta*. ca × 690. **C.** *Microbaculispora barakarensis* Tiwari, 1965 emend. Nature of the trilete mark, proximal view; a sector showing sculptural element on distal face and *extrema lineamenta*. ca × 700. **D.** *Microbaculispora indica* Tiwari, 1965 emend. Nature of trilete mark, proximal view; a sector showing sculptural elements on distal face and *extrema lineamenta*. ca × 575. **E.** *Microbaculispora tentula* Tiwari, 1965. Nature of trilete mark, proximal view; a sector showing sculptural elements on distal face and *extrema lineamenta*. ca × 1240.

1968a *Microbaculispora minuta* Venkatachala & Kar

The miospores are triangular with usually straight, rarely slightly convex inter-apical sides and rounded angles (Pl. 2, fig. 14). Rarely, the specimens are laterally compressed (Pl. 3, figs 26, 27). Most of the specimens range in size from 34 to 48 μm.

The exine thickness is ±1 μm (Pl. 3, fig. 27; Pl. 2, fig. 14). The sculpture consists of bacula with straight sides and flat heads (Text-fig. 3E). Some of the specimens in differential interference contrast reveal the nature of bacula on the exine surface (Pl. 2, fig. 15). They are restricted to the distal and proximo-equatorial region (Pl. 3, fig. 27; Pl. 2, fig. 15), but are absent in the inter-ray areas. Usually the bacula are quite distinct on the *extrema lineamenta* and measure 1×1 μm but sometimes they are not visible due to abnormal flattening of the specimen. In the laterally flattened specimens they are well-marked. In surface view, bacula are evenly distributed and are uniform in size.

Remarks (*125 specimens*) — Specimens included in the present species are comparatively small in overall size. The distinguishing features of this species are the squarish nature and 1×1 μm size of the bacula.

Recently, Foster (1976, pl. 2, figs 8-10) has reported some miospores under this species from Blair Thol Coal Measures, Central Queensland, Australia. In these specimens (mean size 34 μm), variations have been observed in the exine thickness from 0·5-1 μm and in the height of the bacula from 0·5-1·5 μm; they are 1-2 μm apart in surface view. Such variability has not been observed in Indian material. Even Segrove's (1970) *M. tentula* is somewhat different.

Microbaculispora gondwanensis Bharadwaj, 1962

Pl. 1, figs 7-9

Holotype — Bharadwaj, 1962, pl. 2, fig. 33, size 94 μm.

Remarks (*10 specimens*) — The exine, thickness is ±1 μm in the type specimen (re-illustrated here, Pl. 1, figs 8, 9). The distinguishing characters of the species are the nature and size of the bacula 1·5-2 μm long, 1 μm broad with straight sides and flat heads (Text-fig. 3A; Pl. 1, figs 7, 9).

Microbaculispora sp. cf. *M. gondwanensis* Bharadwaj, 1962

Pl. 2, figs 12, 13; Pl. 4, fig. 30

Miospores are usually triangular with broadly rounded angles and slightly convex inter-apical sides (Pl. 2, fig. 13; Pl. 4, fig. 30). The overall size of the specimens is 71-90 μm. Trilete mark is well-marked with almost equal rays which extend up to 4/5 of the spore radius with tapering ray-ends. Usually all the three rays are associated with folds (Pl. 2, figs 12, 13). Exine is thick, 2-3 μm in optical section excluding the equatorial ornament (Pl. 2, fig. 12; Pl. 4, fig. 30). The spores are proximally smooth and distally ornamented with bacula, 1 μm broad, 1·5-2 μm high, with straight sides and flat heads. The nature and distribution of the ornament are very well depicted in the photographs under the differential interference contrast (Pl. 2, fig. 13; Pl. 4, fig. 30).

Remarks (*20 specimens*) — Bharadwaj (1962) described *Microbaculispora gondwanensis* from Raniganj Formation whereas the specimens studied here come from the Barakar Formation. These two compare well with each other but for the exine thickness which is less, i.e. ±1 μm in the specimens from Raniganj Formation. As this seems to be a significant difference coupled with the age difference, the specimens from Barakar Formation have been described as *Microbaculispora* sp. cf. *M. gondwanensis*.

Microbaculispora barakarensis Tiwari (1965) emend.

Pl. 2, figs 10, 11; Pl. 3, figs 18-21

Holotype — Bharadwaj & Tiwari, 1964, pl. 1, fig. 8.

Emended Diagnosis — Miospores triangular to subtriangular. Trilete mark distinct. Exine ±1·5-2 μm thick, distally ornamented with ±2-4 μm high and 2·5-3 μm broad, somewhat dumb-bell-shaped bacula, closely set on *extrema lineamenta*.

Miospores are triangular with broadly rounded angles and ± convex inter-apical

sides (Pl. 2, figs 10, 11) measuring 75-95 μm. Trilete mark is distinct with almost equal rays which extend up to 4/5 of the spore radius with tapering ray ends. Usually all the three rays are associated with folds (Pl. 3, fig. 18). The bacula slightly vary in their nature, i.e. with broad truncate heads, broad base but narrowed in the middle, looking somewhat like a dumb-bell (Text-fig. 3C; Pl. 2, figs 10,11), measuring 2·5-3 μm in width at base and 2-4 μm in height (Pl. 3, fig. 18). In surface view, the bacula are unequal in size measuring 2-3 μm in diameter. Their close setting simulates a negatively reticulate pattern (Pl. 3, fig. 20).

Remarks (*15 specimens*) — Among these specimens, variations have been observed in the overall spore size, and the size and nature of the bacula which do not coincide with the account given by Tiwari (1965). Therefore, the diagnosis has been emended here. This species distinguishes itself by having the characteristic dumb-bell shape of bacula.

Microbaculispora villosa (Balme & Hennelly) Bharadwaj, 1962

Pl. 4, figs 28, 29

1956 *Acanthotriletes villosus* Balme & Hennelly

Remarks (*10 specimens*) — The bacula are 1 μm broad, 3-4 μm long with straight sides and flat head (Text-fig. 3B; Pl. 4, fig. 28).

Other species of the genus Microbaculispora

Microbaculispora variata Tiwari & Navale, 1967

Holotype — Tiwari & Navale, 1967, pl. 1, fig. 9.

Remarks — *M. variata* is characterised by having 2-4 μm wide and 3-6 μm long, finger-shaped bacula with blunt or rounded apices. This species has not been observed in Indian material.

Microbaculispora novica Gupta & Boozer, 1969

Holotype — Gupta & Boozer, 1969, pl. 1, fig. 17.

Remarks — This species is characterised by having 2-3 μm high bacula and overall size-range 41-48 μm. The height of bacula in the present species is different from that in *M. tentula*, and the overall size from that of *M. gondwanensis*. This is yet another report of a widespread spore genus from Gondwanaland occurring in the Pennsylvanian of U.S.A. No specimen assignable to this species has been found during the present study.

Distribution of genus Microbaculispora — According to published literature the genus *Microbaculispora* occurs in Talchir, Karharbari, Barakar and Raniganj formations (Table 3). Besides, various species have also been reported from the Permian deposits of other continents of the Gondwanaland. *M. tentula* is recorded from Permian of Africa, Zäire (Kar & Bose, 1968, 1976; Maheshwari & Bose, 1969; Bose & Maheshwari, 1968) Australia (Rigby & Hekel, 1977; Segroves, 1970; Foster, 1976) and South America (Tiwari & Navale, 1967). *M. indica* has been reported from Zäire (Maheshwari & Bose, 1969; Bose & Maheshwari, 1968), and so also *M. barakarensis* (Maheshwari & Bose, 1969). Occurrence of *M. villosa* has been recorded from the Permian of Australia (Balme & Hennelly, 1956; Rigby, 1973).

Genus — *Microfoveolatispora* Bharadwaj, 1962

Type Species — *Microfoveolatispora raniganjensis* Bharadwaj, 1962.

Remarks — Presence of the folds along the trilete rays is a constant feature. The occasional absence of folds along any one of the three trilete rays is due to abnormal flattening of the specimens. The foveolae size varies not only within the genus but also in the same specimen. Therefore, it is proposed that for each species studied, along with the size-range of the foveolae, mean average value should also be considered. In all these species, the exine thickness is ±1 μm, except in one species where it is ±3 μm.

Systematics — The species so far attributed to this genus are:

Microfoveolatispora raniganjensis Bharadwaj, 1962 — Size range 74-90 μm. Exine 1 μm thick, muri low, 2-3 μm wide, foveolae 2 μm across.

M. trisina (Balme & Hennelly) Bharadwaj, 1962 — Size range 90-110 μm. Exine 1 μm thick, muri narrow, less than 1 μm wide, foveolae 1 μm across.

M. media Bharadwaj *in* Bharadwaj & Srivastava, 1969 — Size range 80-115 μm. Exine ± thick; muri 1-1·5 μm wide, foveolae ± 1·5 μm across.

M. directa (Balme & Hennelly) Bharadwaj, 1962—Size range 36-80 μm. Exine faintly, minutely microfoveolate, thin.

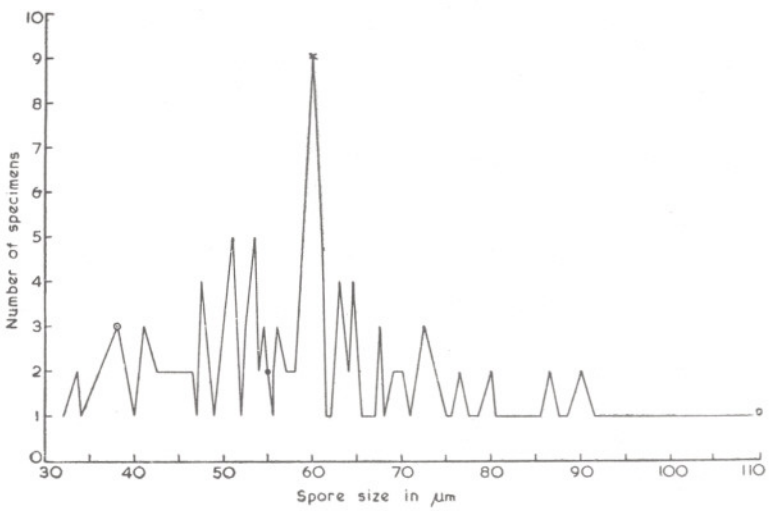
M. bokaroensis Tiwari, 1965 — Size range 70-120 μm. Exine ±3 μm thick; muri low, less than 1 μm wide; foveolae 1-1·5 μm in diameter.

M. foveolata Tiwari, 1965 — Size range 41-56 μm. Exine ±1 μm thick; muri low, less than 1 μm wide, foveolae 1-1·5 μm across.

M. indica Sinha, 1972 — Size range 53-95 μm. Exine ±2 μm thick, foveolae 1 μm wide, faint.

Morphography and Specific Delimitation in the Genus — The present study as well as a review of the published literature on this genus has revealed that the distinguishing morphographic characters on which the species can be delimited are the exine thickness and the size of foveolae. These two characters are variable irrespective of each other. A critical review of literature reveals that the species delimited only on spore size are not dissimilar in morphographic characters and their comparative study shows that the size limits of the miospores for different species exhibit an overlapping tendency among themselves. This fact has also been evidenced from the present study.

Presently, only one species *M. foveolata* Tiwari (1965), has been studied biometrically. Among the specimens of this species, the foveolae size and the exine thickness are within a coherent range of variation but the spore size varies considerably. For evaluating the importance of spore size and further subgrouping in the morphographically similar miospore population, frequency curve has been drawn, and the overall spore size is plotted against the frequency of the miospores (Text-fig. 4). The spore size, recorded presently range from 30 to 110 μm. Here the sizes of the holotypes of *M. trisina*, *M. directa*, *M. foveolata* and *M. indica* (i.e. 109 μm, 38 μm, 55 μm and 60 μm respectively) have also been included. The curve obtained is a normal curve attaining the maximum at 60 μm which represents the existence of a single group having a size range of 30-110 μm. This group has been described as *M. foveolata* emend.



TEXT-FIG. 4 — Frequency curve showing relationship of overall spore size in μm and number of specimens in *Microfoveolatispora foveolata* Tiwari (1965) emend.

The following species are recognized here:
Microfoveolatispora foveolata Tiwari, 1965
M. media Bharadwaj in Bharadwaj and Srivastava, 1969
M. raniganjensis Bharadwaj, 1962
M. bokaroensis Tiwari, 1965

Microfoveolatispora foveolata Tiwari, 1965 emend

Pl. 3, figs 23-25

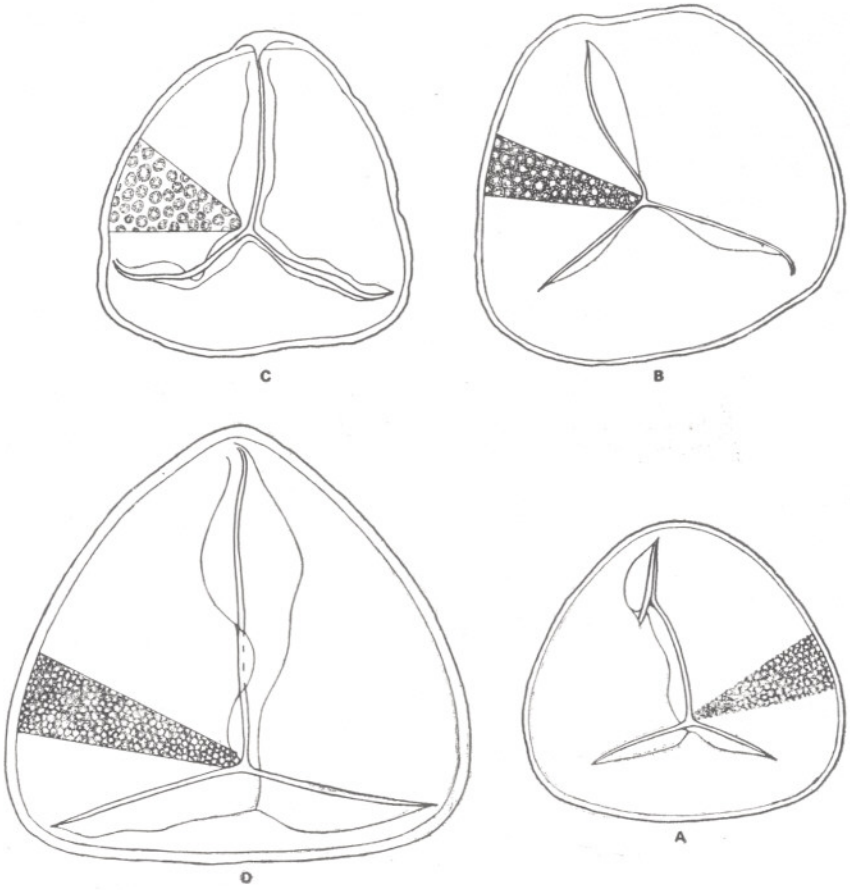
1962 *Microfoveolatispora trisina* (Balme & Hennelly) Bharadwaj, pl. 3, figs 50-53, *pars*.
1962 *M. directa* (Balme & Hennelly) Bharadwaj, pl. 2, figs 45-47, *pars*.
1972 *M. indica* Sinha, pl. 1, figs 23, 24.

Holotype — Tiwari, 1965, pl. 2, fig. 40, size 55 μm.

Emended Diagnosis — Triangular to subtriangular in polar view. Trilete mark distinct, accompanied with folds. Exine thin, proximally smooth, distally foveolate, muri low, foveolae ±1 μm in diameter.

Size Range — 30-110 μm (Text-fig. 4).

Miospores are usually triangular with straight to convex sides. Sometimes the specimens are subtriangular with broadly



TEXT-FIG. 5A-D — **A.** *Microfoveolatispora foveolata* Tiwari (1965) emend. Nature of trilete mark, proximal view; a sector showing foveolae on distal face in top focus. ca × 980. **B.** *Microfoveolatispora media* Bharadwaj (1969). Nature of trilete mark, proximal view; a sector showing foveolae on distal face in top focus. ca × 830. **C.** *Microfoveolatispora raniganjensis* Bharadwaj (1962) emend. Nature of trilete mark on proximal view. A sector showing foveolae on distal face in top focus. ca × 755. **D.** *Microfoveolatispora bokaroensis* Tiwari, 1965. Nature of trilete mark, proximal view. A sector showing foveolae on distal face in top focus. ca × 680.

rounded angles (Pl. 3, fig. 23). Trilete mark is usually distinct (Pl. 3, fig. 23); sometimes it may be subdued due to lateral flattening of the specimen. Trilete rays are equal in length, attenuating towards the equator and extending 4/5 radius or up to the equator. Usually all the three rays of the trilete mark are associated with folds (Pl. 3, fig. 23), which may be missing along any one of the rays. The exine is ±1 μm thick (Pl. 3, fig. 23). The foveolae are the rounded shallow depressions on the exinal surface (Text-fig. 5A; Pl. 3, figs 24, 25), ±1 μm in diameter and with low muri. On the *extrema lineamenta* the foveolae are represented by the uneven nature of margin (Pl. 3, fig. 25).

Remarks (*125 specimens*) — The diagnostic characters described by Tiwari (1965) have been elaborated on the basis of detailed morphographic study and statistical analysis. Accordingly, the spore size now does not remain the sole criterion for delimiting the species and the proposed distinguishing characters are: foveolae ±1 μm in diameter, exine ±1 μm thick, spore size range 30-110 μm. This circumscription encompasses *M. trisina*, *M. directa* and *M. indica* reported from India.

In specimens reported as *Granulatisporites trisinus* and *Leiotriletes directus* by Balme and Hennelly (1956, pl. 1, figs 5-8; pl. 1, figs 1-4), the exine is described to be granulose and psilate to faintly granulose respectively. Hence, such specimens have not been considered here.

Microfoveolatispora media Bharadwaj *in* Bharadwaj & Srivastava 1969c

Pl. 4, figs 31-35; Pl. 5, figs 39, 40

Holotype — Bharadwaj, 1962, pl. 2, fig. 43.

Remarks (*20 specimens*) — The foveolae size varies even in the same specimen, measuring 1-2 μm in diameter (Text-fig. 5B; Pl. 5, fig. 39), with the mean value of 1·5 μm. The foveolae are restricted in their distribution to the distal (Pl. 4, figs 32-35) as well as proximo-equatorial region, being absent in the inter-ray areas (Pl. 4, fig. 31).

Microfoveolatispora raniganjensis Bharadwaj (1962) emend.

Pl. 5, figs 41, 42; Pl. 6, figs 43-47

Holotype — Bharadwaj, 1962, pl. 2, fig. 48, size 80 μm.

Emended Diagnosis — Miospores triangular to subtriangular in polar view. Trilete mark distinct, associated with folds. Exine 1 μm thick, proximally smooth, distally foveolate, muri 1-2 μm wide, foveolae 2-3 μm in diameter.

The overall spore size (studied specimens 28) recorded varies from 40-90 μm (Bharadwaj, 1962 mentioned 74-90 μm). Because of the small number of specimens available, a frequency curve could not be plotted. Exine is ±1 μm thick (Pl. 5, fig. 41). In top focus, foveolae appear as rounded dark spots (Pl. 6, fig. 44). Muri are 1-2 μm thick and foveolae measure 2-3 μm in diameter with a mean value of 2·5 μm (Text-fig. 5C). On *extrema lineamenta*, the presence of the foveolae is marked by the uneven nature of the margin (Pl. 6, fig. 45).

Microfoveolatispora bokaroensis Tiwari, 1965

Pl. 5, figs 36-38; Pl. 6, fig. 48

Holotype — Tiwari, 1965, pl. 2, fig. 44, size 106 μm.

Remarks (*20 specimens*) — The two diagnostic features of the spore are: (i) exine which is up to 3 μm thick (Pl. 5, figs 36-38), and (ii) the foveolae 1-2 μm in diameter (Text-fig. 5D; Pl. 5, figs 36, 38; Pl. 6, fig. 48).

Distribution of genus Microfoveolatispora — This genus occurs from Talchir to Raniganj formations; the distribution of the species is given in Table 3. In the Permian deposits of the continents of Gondwanaland other than India, the genus is represented by *M. directa* (Africa-Zäire; Kar & Bose, 1967; Kar & Bose, 1976) and *M. raniganjensis* (Australia; Grebe, 1970).

Genus — *Didecitriletes* Venkatachala & Kar (1965) emend.

Type Species — *Didecitriletes horridus* Venkatachala & Kar, 1965.

Emended Diagnosis — Amb triangular to subtriangular in polar view and cordate when laterally compressed. Trilete mark distinct, rays associated with folds. Differential distribution of the ornament, i.e. on the distal surface consisting of densely distributed spines and proximally coni of low nature and sparse.

Description — Miospores trilete, mostly triangular in polar view and cordate in

lateral compressions; inter-apical margins straight to slightly convex. Size-range 28-114 μm. Trilete mark distinct, rays extending almost up to equator, usually equal in length and associated with folds. Exine ±1-2 μm thick, proximal sculpture comprising very low and sparse coni, distally ornamented with densely distributed, ± 2-8 μm long, 1-4 μm broad spines with bulbous or broad base and pointed or blunt tips.

Remarks — Genus *Didecitriletes* was described by Venkatachala and Kar (1965) to include miospores having, " exine proximally granulose and distally densely spinose ". However, a re-examination of the type specimen (Venkatachala & Kar, 1965; pl. 1, fig. 1, slide no. 2435/6) shows that sculptural elements on the proximal face are sparsely distributed low coni (Pl. 7, fig. 52) instead of 0·5-1 μm large grana; and the diagnosis has been emended accordingly.

The spines are of a uniform size and most of them have a dark bulbous base and a narrower and lighter in colour rounded apex (Text-fig. 7A). In nature, the spines on *extrema lineamenta* and surface are similar. Sometimes, the spines on margin get broken leaving their remnants in the form of stumps.

This genus can be differentiated from *Anapiculatisporites* Potonié & Kremp (1954) by the prominent folds along the trilete rays and the differential distribution of the ornament. Recently Rigby and Hekel (1977) have designated cf. *Anapiculatisporites longispinosus* Bharadwaj & Salujha (1965, pl. 1, fig. 9) as the type species of this genus instead of the original type — *D. horridus* Venkatachala & Kar (1965) as the latter has been placed in synonymy of the former. However, in cf. *A. longispinosus*, Bharadwaj and Salujha (1965) have not mentioned the differential distribution of the ornament, and the type specimen is also not traceable. Therefore, for the present *D. horridus* should remain as the type species.

Systematics

The species included in the genus are:

Didecitriletes horridus Venkatachala & Kar, 1965 — Size-range 50-64 μm. Exine ±2 μm thick, proximally sparsely granulose, distally spinose, spines 2-6 μm long and 2-3 μm broad at base, interspersed with bacula.

D. ericianus (Balme & Hennelly) Venkatachala & Kar, 1965 — Size-range 39-84 μm, polar axis 36-60 μm. Exine 1-2 μm thick, proximally psilate or with greatly reduced ornament, distally ornamented with acicular or acuminate processes about 2 μm broad at base and up to 7 μm long.

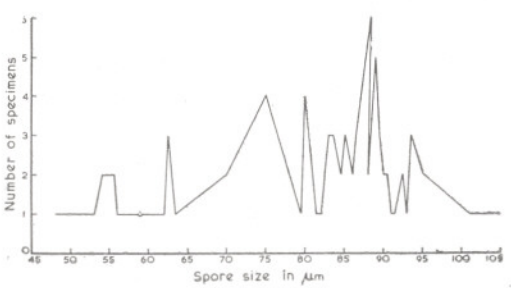
D. dentatus (Balme & Hennelly) Venkatachala & Kar, 1965 — Size-range 78-114 μm. Exine about 2 μm thick, proximally unornamented, distally ornamented with closely set conical processes, 3-4 μm broad at base and 5-7 μm long.

D. uncinatus (Balme & Hennelly) Venkatachala & Kar, 1965 — Size-range 28-46 μm. Exine ±2 μm thick, distally ornamented with spines — 1·2 μm broad at base and 2-8 μm long.

D. bellus Venkatachala & Kar, 1968b — Size-range 65-85 μm. Exine 1·5-2·6 μm thick, proximally granulose, distally ornamented with closely set grana interspersed with bulbous-based spines.

D. spinosus Lele & Maithy, 1969 — Size range 25-40 μm. Exine proximally smooth, distally covered with sparsely arranged spines.

Morphography and Specific Delimitation in the Genus — Venkatachala and Kar (1965) delimited the species in this genus on the basis of the overall size of spores as well as the nature, size and distribution of their spines. However, a re-study of the holotypes of *D. horridus* and *D. bellus* (Slide nos.



Text-fig. 6 — Frequency curve showing relationship in overall spore size in μm and number of specimens in *Didecitriletes horridus* Venkatachala & Kar (1965) emend.

BSIP 2435/6 & BSIP 2489 respectively) reveals that the spines of both species are similar. The frequency curve (Text-fig. 6) plotting spore size against the number of specimens attains its maximum at 88·5 μm indicating the existence of a single miospore population. It is, therefore, evident that *D. horridus* and *D. bellus* are synonyms having no difference in ornament or size.

Thus, on the basis of this analysis, the four species maintained here are: *Didecitriletes horridus* Venkatachala & Kar (1965), *D. ericianus* (Balme & Hennelly) Venkatachala & Kar (1965), *D. dentatus* (Balme & Hennelly) Venkatachala & Kar (1965), and D. *uncinatus* (Balme & Hennelly) Venkatachala & Kar (1965).

Didecitriletes horridus Venkatachala & Kar (1965) emend.

Pl. 7, figs 49-55; Pl. 8, figs 56-61

1968 *Didecitriletes bellus* Venkatachala & Kar.

Holotype — Venkatachala & Kar, 1965, pl. 1, fig. 1, size 59×59 μm.

Emended Diagnosis — Miospores triangular to subtriangular in polar view, cordate in lateral compression. Trilete mark distinct, associated with folds. Exine thin, proximally sparse coni, distally ornamented with spines having bulbous or broad base and pointed or blunt apex.

The miospores have rounded angles and slightly convex inter-apical margins (Pl. 8, fig. 56); sometimes the specimens are laterally preserved (Pl. 8, fig. 57). The size ranges from 48-105 μm but most of the specimens are between 75-94 μm (Text-fig. 6). Trilete rays are almost equal in length, usually extending up to 4/5 of the spore radius with tapering ends, sometimes up to the equator (Pl. 8, fig. 56), sutures are quite marked and are generally associated with folds. Usually all the three rays of trilete mark are associated with such folds (Pl. 8, fig. 56), attenuating towards the equator. Sometimes, the trilete sutures are not visible but the flapy folds on the surface can be seen (Pl. 7, fig. 49; Pl. 8, fig. 57). The exine is ±1 μm in thickness. The distribution of the ornament is differential, with low and sparse coni on proximal face (Pl. 7, figs 49, 52) and larger and denser spines on the distal side (Pl. 7, fig. 53). Each spine has a bulbous base darker than the pointed or blunt apex; a few simple broad-based spines are also present (Pl. 7, fig. 53; Text-fig. 7A). The nature of the ornament has been illustrated here both under normal light as well as in the differential interference contrast (Pl. 7, figs 50, 51, 54; Pl. 8, fig. 59). In some specimens the spines get broken leaving their basal part on *extrema lineamenta* as stumps (Pl. 8, figs 57, 58). Rarely the spines on *extrema lineamenta* are absent (Pl. 8, fig. 56; Text-fig. 7B). The bulbous nature of the spine base is well-marked on the surface having small, beak-like apical part (Pl. 7, figs 53, 54). This beak-like structure gets elongated towards the equator and on *extrema lineamenta* the spine appears as a flask-shaped structure.

Remarks (*85 specimens*) — Venkatachala and Kar (1968b) differentiated *D. bellus* from *D. horridus* by grana interspersed with bulbous-based spines on the distal surface. However, the holotype of *D. bellus* also has bulbous-based spines (Pl. 8, fig. 61) as is the case in *D. horridus*. The other difference between the two species about the ornament at the equator — absent in *D. bellus* (Pl. 8, fig. 61) and present in *D. horridus* (Pl. 7, fig. 53) — is not singificant because of the spines in this group tend to break off. Therefore, *D. bellus* is treated as a synonym of *D. horridus*.

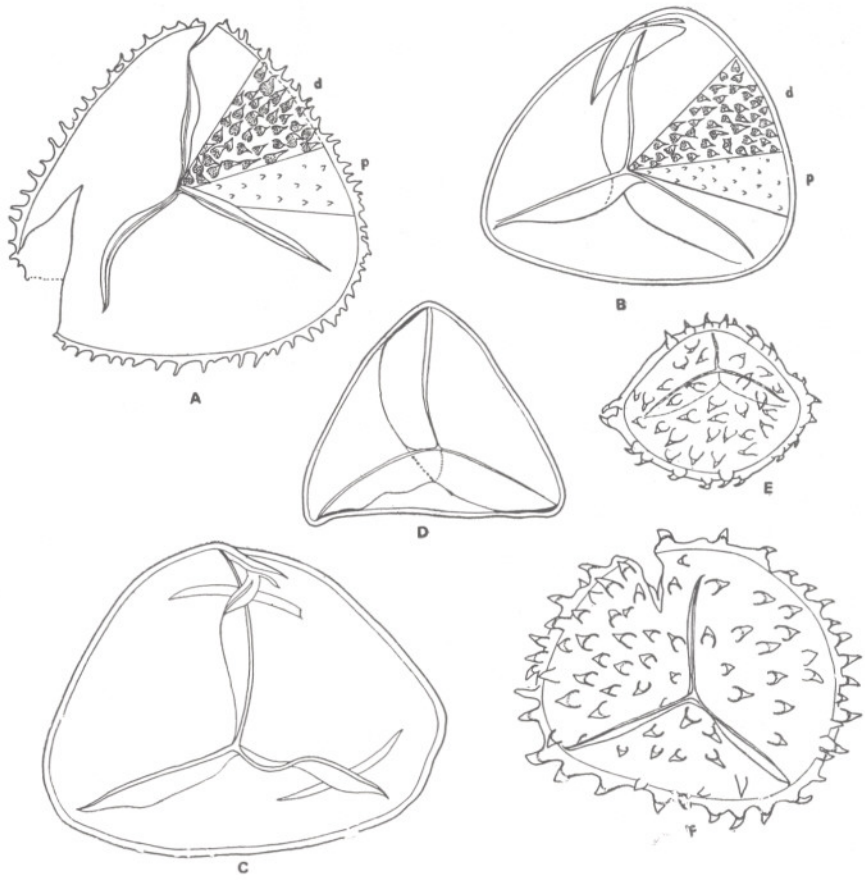
Didecitriletes ericianus (Balme & Hennelly) Venkatachala & Kar, 1965

1956 *Acanthotriletes ericianus* Balme & Hennelly.

1962 *Anapiculatisporites ericianus* (Balme & Hennelly) Bharadwaj

Holotype — Balme & Hennelly, 1956, pl. 3, fig. 30, size 59 μm.

Remarks — Venkatachala and Kar (1965) transferred this species to *Didecitriletes* in view of the association of the rays by thick folds (" lips out-turned or over-folded "; see Balme & Hennelly, 1956; pl. 3, fig. 30), and differential distribution of the ornament on two faces of the miospore. The species has not been found in the samples studied here. *D. ericianus* differs from *D. horridus* in having longer and sparser spines.



TEXT-FIG. 7A-F — **A.** *Didecitriletes horridus* Venkatachala & Kar (1965) emend. Nature of trilete mark, proximal view; Sector d,showing spines on distal face in top focus; Sector p, same on proximal view. ca × 670. **B.** *Didecitriletes horridus* Venkatachala & Kar (1965) emend. Nature of trilete mark, proximal view; Sector d, showing spines on distal view in top focus; Sector p, same on proximal view. ca × 760. **C.** *Lacinitriletes badamensis* Venkatachala & Kar (1965) emend. Nature of trilete mark, proximal view; laevigate exine on both the faces. ca × 580. **D.** *Lacinitriletes minutus* Venkatachala & Kar (1965) emend. Nature of the trilete mark, proximal view; laevigate exine on both the faces. ca × 900. **E.** *Brevitriletes communis* Bharadwaj & Srivastava (1969c). Nature of trilete mark, proximal view; and spines on distal face. ca × 1070. **F.** *Brevitriletes unicus* (Tiwari) Bharadwaj & Srivastava (1969c) emend. Nature of trilete mark, proximal view; spines on distal face. ca × 700.

Didecitriletes dentatus (Balme & Hennelly) Venkatachala & Kar, 1965

1956 *Acanthotriletes dentatus* Balme & Hennelly

Remarks — In having the differential disposition of the ornament and the nature of the Y-mark the species comes under *Didecitriletes*. The holotype appears to be laterally compressed (see Balme & Hennelly, 1956; pl. 3, fig. 34). This species is absent in the samples studied by us.

The species differs from *D. ericianus* in being larger in its overall size and in having 3-4 μm broad ×5-7 μm long, finger-shaped spines on the *extrema lineamenta*. Although this species exhibits slight over-lapping in the overall spore size with that of *D. horridus* it differs from the latter in having finger-shaped spines instead of bulbous-based and pointed spines.

Didecitriletes uncinatus (Balme & Hennelly) Venkatachala & Kar, 1965

1956 *Acanthotriletes uncinatus* Balme & Hennelly.

Holotype — Balme & Hennelly, 1956, pl. 3, fig. 35.

Remarks — The diagnostic features, i.e. trilete rays being associated with flappy folds and exine having uncinate spines (Balme & Hennelly, 1956, pl. 3, fig. 35), of this species relate to that of the genus *Didecitriletes*. It differs from the other species, viz., *D. horridus*, *D. ericianus* and *D. dentatus* in being smaller and in having larger spines.

Didecitriletes spinosus Lele & Maithy, 1969

Synonym of *Brevitriletes communis* Bharadwaj & Srivastava, 1969c

Holotype — Lele and Maithy, 1969, pl. 1, fig. 5, size 26 μm, slide no. BSPI 2825.

Remarks — The type specimen is not available for a re-study but a critical observation of the photograph (Lele & Maithy, 1969, pl. 1, fig. 5) suggests that the specimen is ± subcircular with a distinct trilete mark. The trilete rays reach almost up to equator and are accompanied with folds. The ornamentational processes are spines but apparently they are compound as in *Brevitriletes* Bharadwaj & Srivastava (1969c). Therefore, on the basis of the nature of ornamentation and the overall size given by Lele and Maithy (1969), this species does not find its place in the genus *Didecitriletes* but is closely comparable with *Brevitriletes* of which it has been proposed here to be a synonym.

Distribution of the Genus — *Didecitriletes* occurs in Karharbari, Barakar and Barren Measure formations (Table 3). There is no record of the genus from Talchir and Raniganj formations but it need not necessarily mean that the genus is absent there, although it may suggest that the genus would be found to be rare in the last two formations.

Although the mioflora of the Barakar Formation has been worked out in detail by many workers (see Tiwari, 1974), occurrence of the genus *Didecitriletes* has been reported only from North Karanpura Basin as an important element of the Lower Barakar miofloras.

Outside India, in the Permian deposits of Gondwana continents, the genus *Didecitriletes* is not very well represented. From Australia Grebe (1970) and Rigby and Hekel (1977) recorded certain species of the genus which, however, need re-study in the light of the present work for their exact positioning. A species of the genus has also been recorded by Maheshwari and Bose (1969) from Africa (Zäire).

Genus — *Lacinitriletes* Venkatachala & Kar (1965) emend.

Synonym — *Psilalacinites* 1969b Kar, *Leiotriletes*, (Naumova) Potonié & Kremp, 1954, *pars*.

Type Species — *Lacinitriletes badamensis* Venkatachala & Kar, 1965.

Emended Diagnosis — Amb triangular to subtriangular. Trilete mark distinct, rays associated with folds. Exine smooth — both proximally and distally.

Description — Miospores mostly triangular in polar view, cordate in lateral flattening; apices mostly acutely rounded, inter-apical margins straight to slightly convex. Size-range 22-93 μm. Trilete mark distinct, rays almost equal and extend ± up to equator of the spore, accompanied by thin to thick folds, tapering ends. Exine usually thin and laevigate on proximal as well as distal faces.

Remarks — *Lacinitriletes* was instituted by Venkatachala and Kar (1965) to accommodate — " triangular to subtriangular spores with distinct trilete mark having folds along the trilete rays, the exine being proximally smooth and distally granulose to microverrucose ". However, the photographs of the holotype and other specimens of *L. badamensis* Venkatachala & Kar (1965, pl. 1, figs 8-15) reveal that the exine is devoid of any ornamentation. The re-study of the holotype of *L. badamensis* also exhibits the presence of laevigate exine both proximally and distally (Pl. 9, fig 73 here illustrated). The same type of exine is seen in a number of otherwise similar specimens. It is, therefore, concluded that the genus *Lacinitriletes* should include only unornamented miospores.

Maheshwari and Bose (1969) pointed out that the holotype for the type species (*L. badamensis*) designated by Venkatachala and Kar (1965, pl. 1, fig. 7) belongs *Didecitriletes horridus* Venkatachala and Kar (1965), and that, *L. badamensis* was without a holotype. However, Venkatachala and Kar (1968b) corrected the mistake and now the type *L. badamensis* is fig. 8 on pl. 1 and not fig. 7 on pl. 1. Maheshwari and Bose (1969) assigned this specimen to *Leiotriletes* on the basis of laevigate to microfoveolate exine. Foster (1976) also included *Lacinitriletes* in the synonymy of *Leiotriletes* by pointing out that in certain species of *Leiotriletes*, e.g. *L. directus* Balme & Hennelly, 1956, also the exine is granulose to psilate and the trilete rays are accompanied by folds. However, in our opinion the genus *Leiotriletes* should include only those spores which bear simple trilete rays (see Potonié & Kremp, 1954, pl. 4, figs. 1-3). The rays in *Lacinitriletes* are accompanied by folds.

The type specimen of the genus *Psilalacinites* Kar, re-illustrated here on Pl. 9, fig. 71 (1969b, pl. 1, fig. 1, slide. No. BSIP 3325) has been re-studied and it has been observed that the exine surface is completely smooth. Therefore, *Psilalacinites* should be regarded as a later synonym of *Lacinitriletes*.

Leiotriletes plicatus Maheshwari & Bose (1969) does not possess folds along the trilete rays, but *L. plicatiradiatus* of the same authors has characters similar to *Lacinitriletes badamensis*.

The type specimen of *Psilalacinites indicus* Lele & Makada (1974, pl. 3, fig. 35) is cavate in nature with a thick equatorial cingulum. Evidently, it does not belong to this genus. The photomicrograph of the type specimen of *P. minutus* Kar & Bose (1976, pl. 1, fig. 12) seems to show a cavate spore. It may not belong to *Psilalacinites* at all.

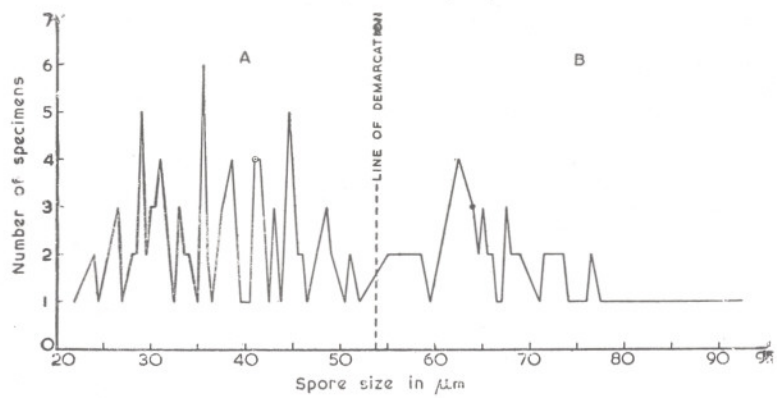
Systematics — Two species are recognized:

Lacinitriletes badamensis Venkatachala & Kar, 1965 — Size-range 50-69 μm. Trilete mark accompanied with folds. Exine ±2 μm thick, proximally smooth and distally granulose to microverrucose, grana ranging from 0·5-1 μm in size.

L. minutus Venkatachala & Kar, 1968a — Size-range 32-46 μm. Trilete rays associated with folds. Exine thin, proximally laevigate, distally microverrucose.

Morphography and Specific Delimitation in the Genus — The organization of the spores of this genus is broadly the same as has been discussed for *Microbaculispora* by Bharadwaj (1962, text-fig. 4A, B). The presently studied miospore population of 132 specimens of the genus exhibits a long range of variation in the spore size; the other characters are not variable. Therefore, the overall spore size remains the only criterion for specific delimitation in the genus.

To evaluate the importance of the spore size in the delimitation of the species a frequency curve has been drawn represent-



TEXT-FIG. 8 — Frequency curve showing relationship of overall spore size in μm and number of specimens in the genus *Lacinitriletes* Venkatachala & Kar (1965) emend.

ing the spore size against the number of specimens (Text-fig. 8). The size of the specimens considered here is the mean-value for each specimen which varies from 22-93 μm. In the curve, two maxima have been obtained — one at 35·5 μm and the other at 62·5 μm. The specimens falling around the 35·5 μm point have been considered as group A, while the specimens around 62·5 μm have been considered as group B. Though these two groups are very coherent to each other in their morphographic characters, they stand separated on the basis of overall spore size. The size-range in group A is 22-52 μm and includes the holotype of *L. minutus* while in group B the size range is 55-93 μm and includes the holotype of *L. badamensis*. The size limits described by Venkatachala and Kar (1965, 1968a) are 50-69 μm for *L. badamensis* and 32-46 μm for *L. minutus*. Evidently, these are the plausible size limits of the two species which are only slightly different from those given by Venkatachala and Kar (1965, 1968a).

Lacinitriletes badamensis Venkatachala & Kar (1965) emend.

Pl. 9, figs 71-73

1969b *Psilalacinites triangulus* Kar, pl. 1, fig. 1.
1969 *Leiotriletes plicatiradiatus* Maheshwari & Bose, pl. 1, figs 12, 13.

Holotype — Venkatachala and Kar (1965), pl. 1, fig. 8, size 69×59 μm.

Emended Diagnosis — Spores triangular to subtriangular in polar view. Trilete mark distinct, trilete rays associated with folds. Exine thin, proximally and distally laevigate.

The miospores included in this species are usually triangular with broadly (Pl. 9, figs 71, 73) to acutely rounded angles and slightly convex inter-apical margins. Maximum number of specimens fall within the range of 60-77 μm. The trilete mark is usually distinct but rarely it may not be discernible due to an abnormal flattening of spores. Trilete rays are equal, with tapering ends, and extend almost up to equator. Mostly all the three rays are associated with folds (Pl. 9, fig. 71). In some specimens, however, the folds are along the two rays and are quite thick because of sub-lateral flattening of the specimen. The nature of the folds along the rays varies even in the same specimen. The exine thickness (±1 μm) is usually well marked (Pl. 9, fig. 71). The exine surface is devoid of any sculpture, both proximally and distally (Pl. 9, fig. 72; Text-fig. 7C). Some of the specimens show dettrital deposit or foreign bodies on the surface which have been identified as such by their irregular nature and inconsistent distribution on the surface as well as the margin.

Remarks (52 specimens) — The photographs of *Psilalacinites triangulus* Kar (1969, pl. 1, figs 1-4) reveal that the exine is smooth on both the faces of the spore. It is thus treated as a synonym of *L. badamensis*. *Leiotriletes plicatiradiatus* Maheshwari & Bose (1969) too is similar to *L. badamensis*.

Lacinitriletes minutus Venkatachala & Kar (1968a) emend.

Pl. 8, figs 62-65; Pl. 9, figs 74, 75

Holotype — Venkatachala & Kar, 1968a, pl. 2, fig. 33, size 46×36 μm.

Emended Diagnosis — Spores triangular to subtriangular in polar view. Trilete mark distinct; trilete rays associated with folds. Exine thin, laevigate both proximally and distally.

Specimens studied (80) are triangular with straight inter-apical margins and rounded or acute angles. In some specimens the inter-apical margins are slightly convex (Pl. 8, fig. 62). Their size ranges from 27-45 μm. The trilete rays are equal and extend up to the equator of the spore (Pl. 8, figs 62, 64) more or less tapering towards the ends. Each ray is associated with folds (Pl. 8, figs 62, 64); but rarely the folds are along two rays (Pl. 9, fig. 75). The exine is usually ±1 μm thick (Pl. 8, fig. 64). A study of the holotype and other specimens, in normal transmitted light and in differential interference contrast (Pl. 8, fig. 65), shows a laevigate exine on both the faces (Text-fig. 7D). It is not " microverrucose " as described by Venkatachala and Kar (1968a).

Distribution of the Genus — The genus *Lacinitriletes* is restricted to the Talchir, Barakar and Raniganj formations (Table 3) of India. It does not have much signi-

ficance as a horizon marker although its presence in association with other morphographically similar genera is quite important from microfloristic point of view.

Lacinitriletes minutus has also been recorded from Zäire (Kar & Bose, 1967) and Rhodesia and South Africa (Chandra, Kar & Lacey, 1977). *L. badamensis* is known to occur in the Permian of Rhodesia and South Africa (Chandra, Kar & Lacey, 1977) and Australia (Foster, 1976).

Genus — *Brevitriletes* Bharadwaj & Srivastava, 1969C emend.

Type Species — Brevitriletes communis Bharadwaj & Srivastava, 1969c.

Emended Diagnosis — Amb subtriangular to subcircular; trilete mark distinct, rays associated with folds; ornamentational processes compound spines, absent in the interray areas, present on distal face and subequatorial region.

Description — Miospore trilete, subcircular to subtriangular. Size-range 16-60 μm. Trilete mark distinct, rays always extending more than 3/4 of the spore radius, associated with folds, ray-ends tapering. Exine 1-2 μm thick, proximally laevigate, distally and equatorially ornamented with compound spines. Spines consisting of conical processes, supporting curved and detachable appendage at apex, constricted in the middle. Number of spines on *extrema lineamenta* 8-30.

Remarks — The association of folds along the trilete rays is a constant feature, although in some specimens, folds may occasionally be absent along one of the rays. The sculputural elements are compound spines of variable nature, i.e. in some specimens each spine has two parts: (i) a basal conical, round-headed projection, and (ii) a supported detachable filiform apical appendage; apical appendage sometimes gets broken leaving the basal conical part (Text-fig. 7E). In other specimens of the genus, the spines are elongated processes being constricted in the middle, forming (i) broad and dense lower part, and (ii) narrow, lighter upper part with a rounded apex (Text-fig. 7F). Here, the upper part is not detachable and is distinguished from the lower one either by the difference in the density or the incipient to well-marked constriction.

Brevitriletes, as emended here, is distinguished from other comparable trilete genera, except those which have been kept in the Varitrileti-group, by having folds along the trilete rays. Among the genera of Varitrileti comparable genus *Didecitriletes* Venkatachala & Kar (1965) differs in having densely distributed spines distally and proximally sparse spines of very low nature.

Systematics — Following seven species have been described so far:

Brevitriletes communis Bharadwaj & Srivastava, 1969c — Size-range 25-44 μm; number of spines on margin 14-20, spine apex rounded having curved, filiform, detachable appendage. Exine up to 3 μm thick with distinctly defined, equatorial thickenings.

B. unicus (Tiwari) Bharadwaj & Srivastava, 1969c — Size-range 38-48 μm; number of spines on margin 10-14, apex rounded. Exine 1-2 μm thick.

B. levis (Balme & Hennelly) Bharadwaj & Srivastava, 1969c — Size-range 25-37 μm; number of spines on margin 8-13, spines round-headed having an apical appendage. Exine ± 1 μm thick.

B. jhingurdahiensis Sinha, 1972 — Size-range 19-36 μm; trilete mark obscure or distinct; sculpture comprising blunt verrucae, spines or coni.

B. crassus Sinha, 1972 — Size-range 15-30 μm, trilete mark mostly obscure; very low sculpture hardly visible on margin. In L-O analysis semi-circular, big puncta seen. Equatorial rim along *extrema lineamenta* ± 1-2 μm thick.

B. baculatus Sinha, 1972 — Size-range ± 20-26 μm; trilete mark obscure, exine distally ornamented with ± 2 μm high, mostly blunt, rarely with swollen-tipped bacula. 7-25 baculae along *extrema lineamenta.*

B. triangularis Kar & Bose, 1976 — Size-range 30-40 μm; long spines 4-20 μm, 15-30 on *extrema lineamenta.* Exine 2-4 μm thick.

Morphography and Specific Delimitation in the Genus — The distal hemisphere in *Brevitriletes* is not deeply curved as in *Microbaculispora* because it has never been preserved in lateral orientation. The species were so far delimited on their size and the number of spines on *extrema lineamenta* (Bharadwaj & Srivastava, 1969c, graphs 7, 8, 9). However, the present morpho-

graphic study of a large miospore population of the genus shows that the primary variation lies in the nature of spines. Spore size and number of spines on margin are the other variables. On the basis of the nature of spines, two groups have been identified in the population of this genus which correspond to *B. communis* (compound spines having detachable apical appendage) and *B. unicus* (compound spines being constricted).

Among these two species, the spore size and the number of spines on *extrema lineamenta* vary considerably. Hence in order to circumscribe the range of the spore size within each species, a frequency curve has been drawn separately. Apart from this, to determine the relationship between the number of spines on *extrema lineamenta* and the spore size, another graph — scatter diagram, has been drawn. The details regarding these graphs are given below.

Among these two species identified here as *B. communis* and *B. unicus*, the present recorded spore-size and the number of spines on *extrema lineamenta* are: 16-45 μm with 8-28 spines and 28-60 μm with 10-30 spines respectively.

The spore size recorded for *B. communis* is 16-45 μm — including the size (37 μm) of the holotype. The frequency curve (Text-fig. 9A) is a normal one attaining its maximum point at 25 μm. This reveals the existence of a single specific group having a size-range from 16-45 μm. The number of spines counted on the margin varies from 8-28. The analysis of the scatter diagram (Text-fig. 9B) reveals that the number of spines varies irrespective of spore size and does not remain a constant feature.

Similarly, in *B. unicus* the same procedure has been followed as for *B. communis*. The recorded spore-size varies from 28-60 μm, which also includes the size (i.e. 43 μm) of the holotype. The curve attains its maximum point at 45 μm (Text-fig. 9C) deciphering the existence of a single group with 28-60 μm size-range. The number of spines also varies irrespective of the spore size, i.e. from 10-30 as is apparent in the scatter diagram (Text-fig. 9D).

This reveals that the number of spines is not a sound criterion for specification. On the basis of this analysis the range of the spore size as well as that of the number of spines have been enlarged in comparison to the range originally given by Bharadwaj and Srivastava (1969c).

With new circumscriptions, two species have been maintained under this genus, viz., *Brevitriletes communis* Bharadwaj & Srivastava (1969c) emend. and *B. unicus* (Tiwari) Bharadwaj & Srivastava (1969c) emend.

Brevitriletes communis Bharadwaj & Srivastava, 1969 emend.

Pl. 9, figs 70, 76, 77; Pl. 10, figs 81, 82, 87, 88

1969c *Brevitriletes levis* (Balme & Hennelly) Bharadwaj & Srivastava: Balme & Hennelly, 1956.

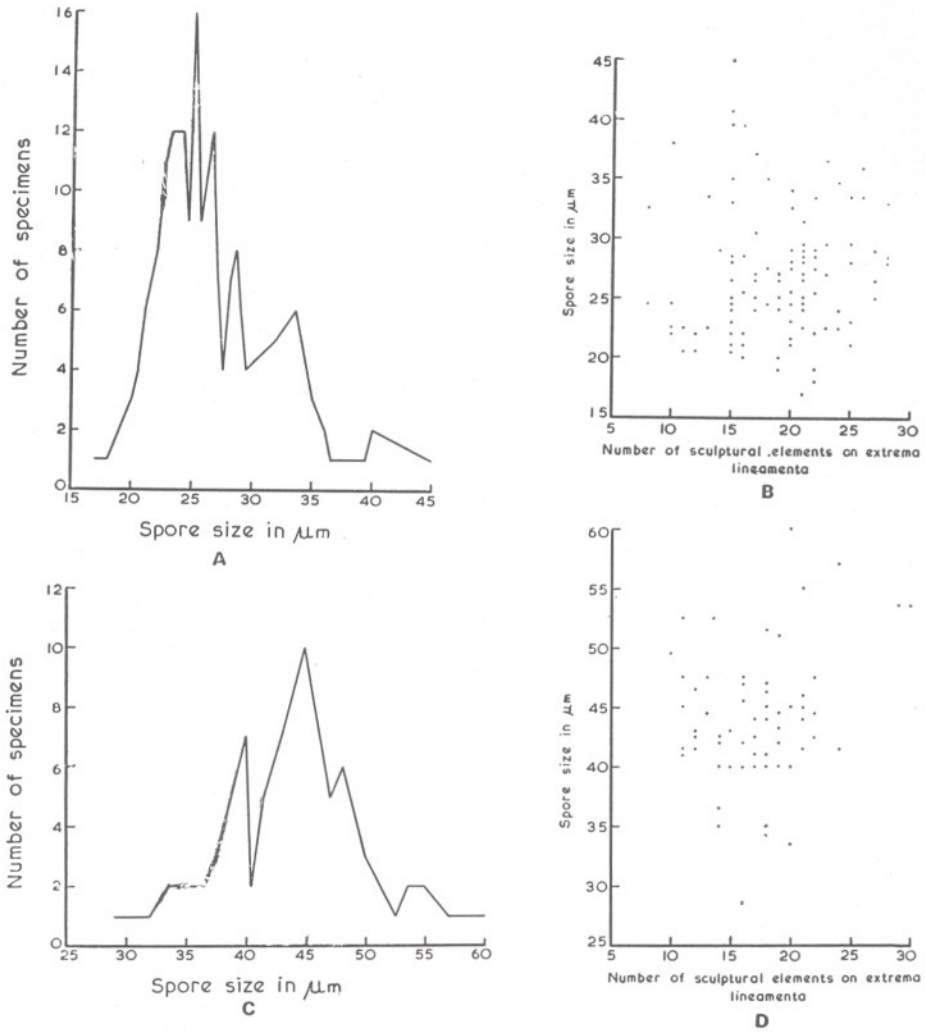
1976 *B. triangularis* Kar & Bose, pl. 3, figs 18,19.

Holotype — Bharadwaj & Srivastava, 1969c, pl. 1, fig. 12, size 37 μm.

Emended Diagnosis — Miospores subtriangular to subcircular. Trilete mark distinct. Exine thin to thick, distally and proximo-equatorially ornamented with compound spines having detachable apical appendage. On the *extrema lineamenta* 8-28 spines.

The spores are usually subcircular (Pl. 10, fig. 87), sometimes subtriangular with rounded angles and slightly convex sides (Pl. 10, fig. 82). Most of them measure 22-33 μm. The trilete rays are usually distinct, rarely obscure almost equal extending up to the equator, with tapering ray-ends and are accompanied with folds (Pl. 10, figs 81, 82) attenuating towards the equator. The exine is 1-2 μm thick but it is ± 1 μm in a majority of the specimens (Pl. 10, fig. 87). In some of the specimens the thickness has been recorded to be ±2 μm.

As already discussed, the ornamentational processes are not the spines in true sense (see p. 271, Text-fig. 7E; Pl. 10, figs 81, 82, 87). The apical appendage is usually present but gets broken in some (Pl. 10, fig. 81), leaving back only the conical stumps. Spines measure 1-3 μm long including the apical appendage and 1-2 μm broad at the base. In nature, the spines on the surface and on *extrema lineamenta* are similar. In number, spines counted on *extrema lineamenta* vary from 8-28, usually in a range of 15-20 as is apparent from Text-fig. 9B.



TEXT-FIG. 9A-D — **A.** Frequency curve showing relationship of overall spore in μm and number of specimens in *Brevitriletes communis* Bharadwaj & Srivastava (1969) emend. **B.** Scatter diagram showing relationship of overall spore size in μm and number of spines on *extrema lineamenta* in *Brevitriletes communis* Bharadwaj & Srivastava (1969) emend. **C.** Frequency curve showing relationship of overall spore size in μm and number of specimens in *Brevitriletes unicus* (Tiwari) Bharadwaj & Srivastava (1969c) emend. **D.** Scatter diagram showing relationship of overall spore size in μm and number of spines on *extrema lineamenta* in *Brevitriletes unicus* (Tiwari), Bharadwaj & Srivastava (1969c) emend.

Remarks (*162 specimens*) — *Apiculatisporites levis* is characterised by a distinct contact area as described and figured by Balme and Hennelly (1956, pl. 2, figs 19-21). Therefore, it is maintained as a separate taxon since the size and ornamentation of specimens described as *B. levis* by Bharadwaj and Srivastava (1969c, pl. 1, figs 17-20) resemble those of *B. communis*; these specimens are assigned here to *B. communis*. *B. triangularis* Kar & Bose (1976, pl. 3, figs 18, 19) has only ±1 μm thick exine (not 2-4 μm as described originally) and up to 4 μm long spines (not up to 10 μm). This species seems to resemble *B. communis*.

Brevitriletes unicus (Tiwari) Bharadwaj & Srivastava, 1969c emend.

Pl 9, figs 66-69, 78, 80; Pl. 10, fig. 84

Holotype — Tiwari, 1965, pl. 1, fig. 30, size 43 μm.

Emended Diagnosis — Miospores subtriangular, angles broadly rounded, sides slightly convex. Trilete mark distinct. Exine thin, distally and proximo-subequatorially ornamented with compound constricted spines. On *extrema lineamenta* 10-30 spines present.

The miospores are usually subtriangular with broadly rounded angles, slightly convex sides (Pl. 9, fig. 66), sometimes subcircular due to prominent convex nature of the inter-apical sides (Pl. 9, fig. 68). The trilete mark is usually distinct but rarely indistinct (Pl. 9, fig. 70). Trilete rays are almost equal usually extending up to 3/4 of the spore radius (Pl. 9, fig. 66), rarely reaching up to equator (Pl. 9, fig. 78) with tapering ray ends. The rays are associated with folds attenuating towards the equator (Pl. 9, fig. 66). Exine is ±1-2 μm thick (Pl. 9, figs 66, 80).

The ornament consists of compound spines, somewhat constricted in the middle having (i) broad, dense lower portion, and (ii) less dense upper narrow portion with rounded apex (Text-fig. 9F). The upper portion of the spine is not detachable and is distinguished from the lower one only by its different density or in incipient to well-marked median constriction (Pl. 9, figs 66, 69; Pl. 10, fig. 84). The spines have a rounded apex and measure ±2-5 μm long and 1·5-3 μm borad at base (Pl. 9, figs 66, 68, 70). Ornamentational processes on the surface are like those at the margin (Pl. 9, fig. 68) and usually close to each other. The spines are 10-30 in number (Text-fig. 9D) at *extrema lineamenta*.

Remarks (*80 specimens*) — The number of spines on *extrema lineamenta* has not been found to be a sound criterion for specific delimitation as given by Bharadwaj and Srivastava (1969c). Recently Kar and Bose (1976, pl. 3, figs 16, 17) have reported some specimens as *B. unicus* having 5-10 μm long spines within the overall spore size-range of 43-50 μm. However, in the photographs the length of the spines seems to be less than 5 μm. On the basis of bulbous-based spines these specimens are referable to *B. unicus*.

Other species of the genus Brevitriletes

?*Brevitriletes jhingurdahiensis* Sinha, 1972

Pl. 10, figs 86, 91, 100

Remarks — The holotype of this species (Sinha, 1972, pl. 1, fig. 15, slide no. BSIP 4102) has been re-studied and it has been found to possess simple trilete mark and contact areas on the proximal side and small coni on the distal side. These important features have neither been described by Sinha (1972) nor are clear in the photograph given by her. The specimen has been re-illustrated here (Pl. 10, fig. 86). In *Brevitriletes* the arcuate rims are absent and trilete rays are accompanied with folds, hence *B. jhingurdahiensis* does not find its place in this genus. *B. jhingurdahiensis* Sinha (1972) is comparable to *Godavarisporites indicus* Tiwari & Moiz (1971) which possesses contact areas delimited by arcuate rims and hence, is a junior synonym of the latter. A few other specimens assignable to this species (Pl. 10, figs 91, 100) were also found during this study.

Brevitriletes crassus Sinha, 1972

Pl. 10, fig. 89

Holotype — Sinha, 1972, pl. 1, fig. 18, size 22 μm, slide no. BSIP 4102.

Remarks — The species has the following morphographic characters: "Subcircular to subtriangular miospores; 15-30 μm in size; trilete mark obscure or distinct; ornamentation only on distal face, comprising very low to indistinct sculpture; equatorial thickening present". However, a re-study of the holotype revealed an indistinct trilete mark without folds, very reduced sculptural elements, possibly coni, and an unevenly thick exine. The specimen has been re-photographed to illustrate these characters (Pl. 10, fig. 89). Obviously this species does not find its place in the genus *Brevitriletes*.

Brevitriletes baculatus Sinha, 1972

Holotype — Sinha, 1972, pl. 1, fig. 19, size 21×24 μm.

Remarks — This species includes specimens having the following characters: " Subcircular to circular miospores, ±20-26 μm size, trilete mark obscure distally ornamented with big blunt bacula ". The holotype of this species has not been restudied as the specimen could not be traced in the type slide but even on the basis of original diagnosis this species does not find its place in the genus *Brevitriletes*, which is characterised by having distinct trilete mark accompanied with folds and having compound spines as the ornamentational processes. This species should find a place under the genus *Apiculatisporis* Potonié & Kremp (1954).

Distribution of Genus — Table 3 gives the stratigraphical distribution of *Brevitriletes* in the Indian Lower Gondwana horizons. It was previously recorded from Talchir, Karharbari and Barakar formations, but recently it has also been recorded from Barren Measure, Raniganj and Panchet formations. Genus *Brevitriletes* has also been recorded from South Africa (Tiwari, 1974) and Zäire (Kar & Bose, 1976).

Genus — *Imparitriletes* gen. nov.

Type Species — Imparitriletes korbaensis sp. nov.

Diagnosis — Miospores trilete, triangular; trilete rays associated with folds. Exine proximally smooth, distally sculptured with grana.

Description — Miospore triangular to subtriangular in polar view with slightly convex inter-apical margins and rounded angles. Overall size from 26-60 μm. Trilete mark distinct, rays extending more or less up to the equator associated with folds. Exine ± 1 μm thick in optical section excluding the equatorial ornamentation. Proximally smooth, distally ornamented with closely distributed grana, ± 1·0 μm in diameter having semi-circular relief in lateral view. Some of the grana fused among themselves and imparting an irregular appearance. On *extrema lineamenta* 1 μm wide × 0·5-1 μm high grana.

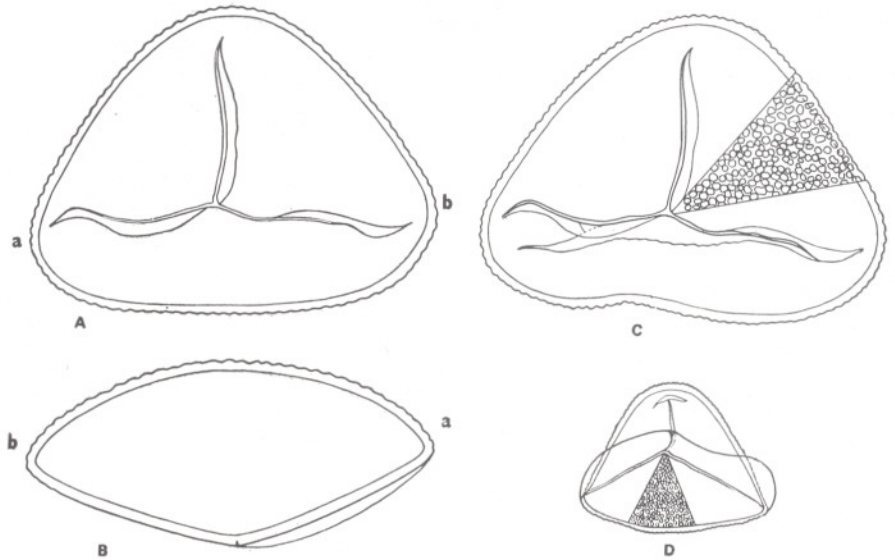
Comparison — The genus differs from other trilete genera such as *Acanthotriletes* (Naumova) Potonié & Kremp (1954), *Lophotriletes* (Naumova) Potonié & Kremp (1954), *Leiotriletes* (Naumova) Potonié & Kremp (1954) and *Anapiculatisporites* Potonié & Kremp (1954) in the nature of sculpture and the trilete mark. In *Granulatisporites* (Ibrahim, 1933) Potonié & Kremp (1954) the ornamentation comprises grana which are distributed all over the spore body, and the trilete mark is simple without any fold.

Imparitriletes is easily distinguishable from other genera of the Varitrileti-group, such as *Microbaculispora* Bharadwaj (1962, baculae), *Microfoveolatispora* Bharadwaj (1962, foveolae), *Didecitriletes* Venkatachala & Kar (1965, spines) and *Brevitriletes* Bharadwaj & Srivastava, (1969c, spines). *Imparitriletes* apparently resembles the original diagnosis of *Lacinitriletes* Venkatachala & Kar (1965) where the exine is described to possess granulose to microverrucose sculpture distally but smooth proximally. However, as stated earlier, the holotype and other specimens of *L. badamensis* have laevigate exine, and thus it differs from *Imparitriletes*.

Derivation of Name — Impar (L) meaning unequal in dimensions.

Organization — The specimens flattended in polar view usually have median placed trilete mark (Pl. 10, fig. 85) and are triangular in shape with straight (Pl. 10, fig. 85) to slightly convex inter-apical margins (Pl. 10, fig. 90). Sutures of the trilete are accompanied with folds (Pl. 10, figs 90, 102). Sometimes such folds may be along only two or one of the three rays. The grana appear circular to semicircular in surface view (Pl. 10, figs 95, 103) and round-headed, low projections on *extrema lineamenta* (Pl. 10, figs 85, 103). In the meridionally flattened specimens the trilete mark is partly in view, but the nature and distribution of the sculptural elements are more distinctive in such a view. They are restricted to the distal and proximo-equatorial region of the spore (Pl. 10, fig. 95). The organization for this genus has been suggested as given in Text-fig. 10.

Variability — The only variable feature observed is the overall size of the specimens. On the basis of the nature and size of grana, all the specimens studied here are alike and hence they do not show any distinct specific groups. The frequency curve



TEXT-FIG. 10**A-B** — Organization of spore genus *Imparitriletes* gen. nov.— polar view. ca × 1110. **B.** Meridional section along A-B in Text-fig. 10A. ca × 1110. **C.** *Imparitriletes korbaensis* sp. nov., Holotype. Nature of trilete mark, proximal view; a sector showing grana on distal face, ca × 1100. **D.** *Imparitriletes korbaensis* sp. nov. Nature of trilete mark and of grana in the laterally flattened specimen in the species. ca × 1220.

for spore size obtained after plotting all the available observations is a normal curve (Text-fig. 11) which attains its maximum at 41 μm with almost equal observations on both sides. Evidently this study also indicates the existence of a single group, to which a specific name *Imparitriletes korbaensis* sp. nov. has been given. The size-range within this species is from 26-60 μm. Most of the specimens measure in the range of 33 to 49 μm.

Imparitriletes korbaensis sp. nov.

Pl. 10, figs 83, 85, 90, 92-98,101-103

Holotype — Pl. 10, fig. 85, size 46·5 μm.

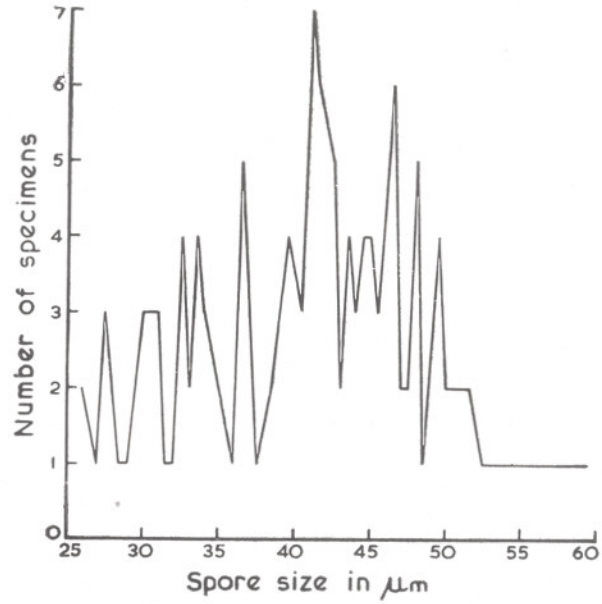
Type Locality — Korba Coalfield (Madhya Pradesh), India, Borehole no. NCKB-19, sample no. 130.

Horizon & Age — Karharbari Formation, Lower Permian.

Diagnosis — Miospores triangular to subtriangular in polar view. Trilete mark distinct, rays associated with folds. Exine thin, proximally smooth, distally ornamented with 0·5-1 μm high and 1 μm wide, rounded grana.

The miospores (specimens studied 110) considered under this species are usually triangular with ± straight inter-apical margins and acutely or broadly rounded angles (Pl. 10, figs 85, 94) to uneven inter-apical sides and acutely rounded angles (Pl. 10, fig. 103). Sometimes the specimens are laterally flattened (Pl. 10, fig. 95), distorting the normal triangular shape. The trilete observed in these specimens is usually well-marked, rarely indistinct due to sub-lateral flattenings of the specimens during preservation (Pl. 10, fig. 103). Trilete rays are almost equal in length (Pl. 10, figs 85, 94) extending up to 4/5 of the spore radius (Pl. 10, fig. 85). In some cases they extend up to equator (Pl. 10, fig. 94) attenuating towards the equator. Usually all the three rays are accompanied with folds (Pl. 10, fig. 90); in some specimens such folds are present along two rays only. Exine thickness is ± 1 μm, usually well demarcated in all the specimens (Pl. 10, figs 85, 93).

The photographs under the differential interference contrast reveal that the ornamentational processes are the semirounded



TEXT-FIG. 11 — Frequency curve showing relationship of overall spore size in μm and number of specimens in *Imparitriletes korbaensis* sp. nov.

elevations on the exine surface (Pl. 10, figs 96, 98) and they are restricted to the distal and the proximo-equatorial region of the spore (Pl. 10, figs 95, 98) being absent from the inter-ray areas. Grana are + 1 μm wide at base and ± 0·5-1 μm high with rounded heads (Text-fig. 10C, D). In smaller specimens of this species, the grana on *extrema lineamenta* are ± 0·5 μm high and ± 1 μm wide (Pl. 10, fig. 83) while in the other specimens they are well-marked, 1 μm wide at base and up to 1 μm high (Pl. 10, fig. 103). In surface view, grana are evenly distributed looking almost circular (Pl. 10, figs 85, 102). The inter-granular spaces form negative reticulum in low focus. It has also been observed that irrespective of the spore size some of the grana get fused to form somewhat irregular sculptural pattern at places (Pl. 10, figs 93, 103). All the variations described above have been illustrated in the photographs.

Comparison — Present species is apparently comparable to *Microbaculispora tentula* Tiwari (1965) but differs in possessing definite grana rather than the bacula. In surface view the ornament in some specimens (Text-fig. 10D) may appear similar to that of *M. tentula* (Text-fig. 3E) but the distinction in the two can be very well made when the ornament on the *extrema lineamenta* is carefully examined. In the case of present species, the grana project out as dome-shaped, semi-circular objects with rounded sides while in the case of *M. tentula* the bacula can be differentiated by their straight, more or less parallel sides, flat tops and rod-like nature. No other species from the genera included in Varitrileti is comparable.

SPECIFIC DISTRIBUTION OF VARITRILETI GROUP THROUGH LOWER GONDWANA FORMATIONS OF INDIA

The stratigraphical distribution of each genus of the Varitrileti-group at specific level has been determined in well-dated successions (Table 2), which collectively represent the complete Lower Gondwana Sequence — from Talchir Formation to Raniganj Formation. For the Barren Measures, of which no complete sequence could be obtained for analysis, the information given in the present work is based

TABLE 3

FORMATION	ASSOCIATION OF CHARACTERISTIC SPECIES	OCCURRENCE
8. Raniganj	*Microbaculispora gondwanensis*	0×
	M. indica	+
	M. tentula	+
	Microfoveolatispora foveolata	+++
	M. raniganjensis	+×
	M. media	*
	Didecitriletes horridus	+
	Lacinitriletes badamensis	0×
	L. minutus	+++
	Brevitriletes unicus	*
	B. communis	+
7. Barren Measures	*Lacinitriletes badamensis*	++
	Didecitriletes horridus	++
6. Upper Barakar	*Microbaculispora barakarensis*	+
	M. indica	+++
	M. tentula	+
	Microfoveolatispora foveolata	+++
	Lacinitriletes badamensis	0
	L. minutus	+
	Brevitriletes unicus	+
	B. communis	+
5. Middle Barakar	*Microbaculispora barakarensis*	++
	M. indica	+++
	M. tentula	+
	Microfoveolatispora foveolata	++
	Lacinitriletes minutus	+
	L. badamensis	*
	B. communis	+
4. Lower Barakar	*Microbaculispora barakarensis*	+
	M. indica	++
	M. tentula	+++
	Microfoveolatispora foveolata	+
	Lacinitriletes badamensis	*
	L. minutus	+
	Brevitriletes unicus	+
	B. communis	+++
3. Upper Karharbari	*Microbaculispora barakarensis*	+
	M. indica	++
	M. tentula	+
	Microfoveolatispora foveolata	+
	Lacinitriletes badamensis	*
	L. minutus	+
	Brevitriletes unicus	+
	B. communis	+++
	Imparitriletes korbaensis	0
2. Lower Karharbari	*Microbaculispora barakarensis*	*
	M. indica	+
	M. tentula	++
	Microfoveolatispora foveolata	++
	Lacinitriletes badamensis	0
	L. minutus	+
	Brevitriletes unicus	+
	B. communis	+
	Imparitriletes korbaensis	+++
1. Talchir	*Microbaculispora indica*	*
	M. tentula	+++
	Microfoveolatispora foveolata	+
	Lacinitriletes minutus	0
	Brevitriletes unicus	*
	B. communis	0
	Imparitriletes korbaensis	+++

In the above table, following signs have been used to indicate the relative percentage frequencies: dominant: +++, abundant: ++, common: +, rare: 0, inconsistent: ×, in traces: *.

only on the slides available from Jharia Coalfield (Bharadwaj, Sah & Tiwari, 1965).

The findings have revealed that all the species of the group — Varitrileti do not occur in each horizon and, if present the percentage frequency is variable (Table 4). On the basis of this observation, the species which collectively represent the Varitrileti assemblage for each horizon have been given below. The average percentage frequency for each species represented in each horizon has been given in Histogram 1.

In the Talchir Formation, the Varitrileti species present are: *Microbaculispora tentula*, *Microfoveolatispora foveolata*, *Lacinitriletes minutus*, *Brevitriletes communis* and *Imparitriletes korbaensis*. Among these, the dominant species are: *M. tentula* and *I. korbaensis* while the common ones are: *M. foveolata* and *B. communis*. Besides, the other species which occur in traces are: *Microbaculispora indica* and *Brevitriletes unicus* and the rare one is *Lacinitriletes minutus*.

The Varitrileti assemblage characteristic for the Lower Karharbari Formation is represented by the species: *Microbaculispora indica*, *M. tentula*, *Microfoveolatispora foveolata*, *Lacinitriletes badamensis*, *L. minutus*, *Brevitriletes unicus*, *B. communis* and *Imparitriletes korbaensis*. The only dominant element among these is *Imparitriletes korbaensis*. The percentage frequency of *M. tentula* decreases here considerably in comparison to Talchir Formation. The other common species are — *L. badamensis*, *L. minutus*, *B. unicus*, *B. communis* and *M. indica*. In Lower Karharbari the only species of this group occurring in traces is *Microbaculispora barakarensis*. The dominant species in the Talchir Formation are: *M. tentula* and *I. korbaensis* (with *M. indica* in traces); in the Lower Karharbari Formation, the dominant species is *I. korbaensis* while *M. barakarensis* is in traces.

Varitrileti assemblage of the Upper Karharbari Formation is represented by the occurrence of *Microbaculispora barakarensis*, *M. indica*, *M. tentula*, *Microfoveolatispora foveolata*, *Lacinitriletes minutus*, *Brevitriletes unicus*, *B. communis* and *Imparitriletes korbaensis*. Here the dominant species is *B c.momunis*, which has been common in the older assemblages. Apart from this, the occurrence of *M. indica* is abundant and that of *M. tentula* is common along with *M. foveolata*. The other common species are *L. minutus*, *B. unicus*, *I. korbaensis* and also *M. barakarensis*, which is present in traces in the Lower Karharbari Formation. *L. badamensis* is the only species of the group to be present in traces here. It is important to note here that percentage of *I. korbaensis* considerably decreases as compared to its occurrence in older horizons where it is in dominance and the occurrence of *M. barakarensis* as a common species in present Varitrileti assemblage.

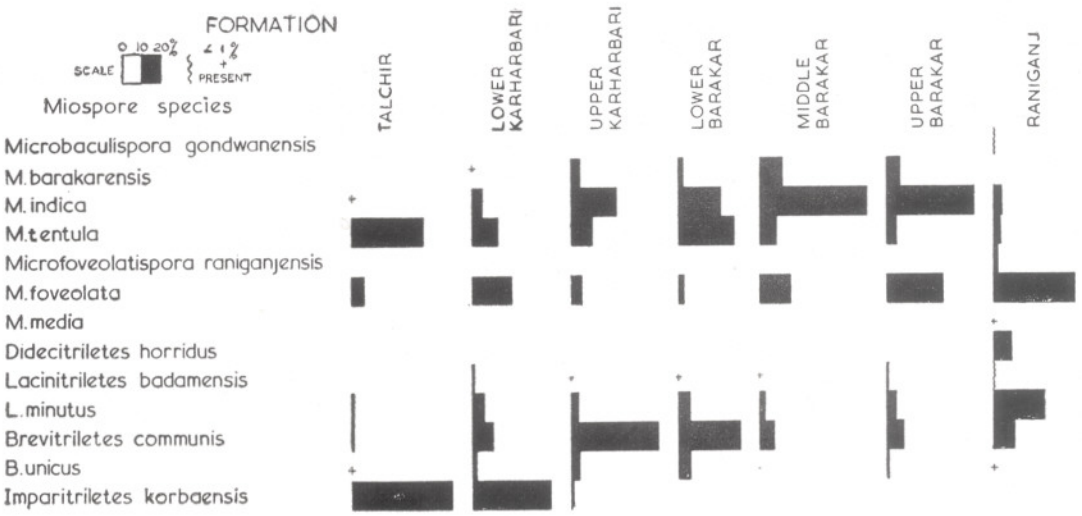
The Varitrileti assemblage of the Lower Barakar Formation is represented by the presence of *Microbaculispora barakarensis*, *M. indica*, *M. tentula*, *Microfoveolatispora foveolata*, *Lacinitriletes minutus*, *Brevitriletes unicus* and *B. communis*. Here again the dominant species is *B. communis* with *M. tentula*. *M. indica* occurs in abundance. Besides, the common species are — *M. foveolata*, *L. minutus*, *B. unicus* and *M. barakarensis*. The only species found to be present in traces is *L. badamensis*. The Varitrileti assemblage of the Lower Barakar Formation differs from that of the Upper Karharbari Formation by the absence of *Imparitriletes korbaensis*.

In the Middle Barakar Formation, the Varitrileti assemblage records the presence of *Microbaculispora barakarensis*, *M. indica*, *M. tentula*, *Microfoveolatispora foveolata*, *Lacinitriletes minutus* and *Brevitriletes communis*. Here the dominant species is *M. indica*. *M. barakarensis* and *M. foveolata* are abundant. The percentage of *B. communis* and *M. tentula* decreases while *L. minutus* remains unchanged. The species which are present in traces are *L. badamensis* and *B. unicus*. The Varitrileti assemblage of the Middle Barakar Formation is similar to that of Lower Barakar Formation in respect of different species. The only difference is in their percentage frequency.

Different species present in the Upper Barakar Formation are: *Microbaculispora barakarensis*, *M. indica*, *M. tentula*, *Microfoveolatispora foveolata*, *Lacinitriletes badamensis*, *L. minutus*, *Brevitriletes unicus* and *B. communis*. The species present in dominance are *M. indica* and *M. foveolata*.

TABLE 4 — PERCENTAGE FREQUENCY OF SPECIES REPRESENTING VARITRILETI ASSEMBLAGES THROUGH LOWER GONDWANA SEQUENCE OF INDIA

Formation:	Talchir		Lower Karharbari					Upper Karharbari		Lower Barakar			Middle Barakar				Upper Barakar					Raniganj													
Sample No.:	138	137	132	130	129-126	119	117a	110	112	10	12a	C1-C9	39a	40	46/3	46/4	47	67d	67e	68	78a	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Miospore species																																					
Microbaculispora gondwanensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–
M. barakarensis	–	–	–	+	–	+	+	6·8	2·5	1·9	4·5	+	16·6	13·3	8·3	6·2	13·3	8·3	5·5	5·2	2·3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M. indica	+	+	4·5	2·6	3·6	11·1	5·0	27·2	20·0	19·6	9·0	35·7	66·6	60·0	58·3	34·3	73·3	75·0	38·8	23·6	11·9	3·1	+	30·0	2·7	2·8	+	+	3·8	4·0	11·1	0·7	2·5	3·6	+	–	+
M. tentula	38·0	37·6	18·1	13·3	19·2	1·8	15·0	11·3	10·0	2·9	54·5	28·5	8·3	13·3	8·3	3·1	6·6	4·1	5·5	2·6	—	15·0	+	–	5·0	22·8	+	–	9·6	–	1·3	–	+	3·6	+	2·9	+
Microfoveolatispora raniganjensis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9·3	–	+	–	19·0	+	+	+	–	–	3·1	+	+	–	+	–
M. foveolata	9·5	3·5	13·6	4·0	3·6	57·3	17·5	9·0	2·5	0·9	+	7·2	+	+	16·6	46·8	–	+	33·3	47·6	64·0	46·8	+	55·0	36·0	26·6	51·4	52·3	36·5	38·0	20·1	73·2	52·5	58·1	10·9	61·9	14·2
M. media	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–	+	–	–	–	+	–
Didecitriletes horridus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18·7	+	+	2·7	1·9	+	+	7·6	48·0	52·7	0·7	+	1·8	+	+	+
Lacinitriletes badamensis	–	–	4·5	2·6	+	+	–	+	+	+	–	–	–	+	–	–	–	–	–	5·2	+	–	–	+	+	1·9	4·7	+	+	+	2·7	0·7	+	+	+	4·7	+
L. minutus	2·3	1·1	9·0	6·6	7·6	15·5	2·5	4·5	–	0·9	13·6	3·5	+	6·6	+	3·1	+	4·0	5·5	7·8	7·1	6·2	+	10·0	44·4	24·7	43·8	40·0	40·4	2·0	11·1	16·6	37·5	14·5	23·6	27·6	45·7
Brevitriletes communis	2·3	1·1	9·0	1·3	26·9	7·4	10·0	34·0	57·5	68·6	18·1	11·0	8·3	6·6	8·3	6·2	6·6	8·3	11·1	5·2	9·5	+	+	5·0	2·7	+	+	7·6	1·9	8·0	+	4·7	7·5	18·1	58·1	2·8	40·0
B. unicus	+	+	+	–	+	12·6	+	4·5	5·0	4·8	+	14·2	+	+	+	+	+	–	+	2·6	4·7	–	–	–	–	–	–	–	–	+	–	–	–	–	7·2	+	+
Imparitriletes korbaensis	47·6	56·4	40·9	60·3	38·4	3·7	50·0	2·2	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–



HISTOGRAM 1 — Composite histogram showing the average percentage frequency of various miospore species of Varitrileti Group in each formation of the Lower Gondwana Sequence studied here.

The common ones are — *M. barakarensis*, *M. tentula*, *L. minutus*, *B. unicus* and *B. communis*. The only rare species is *L. badamensis*.

In the Barren Measure Formation as analysed here, *Lacinitriletes badamensis* and *Didecitriletes horridus* are reported to occur.

The different species present in the Raniganj Formation are: *Microbaculispora gondwanensis*, *M. indica*, *M. tentula*, *Microfoveolatispora foveolata*, *M. raniganjensis*, *M. media*, *Lacinitriletes badamensis*, *L. minutus*, *Brevitriletes communis* and *Didecitriletes horridus*. The species which occur in traces are — *B. unicus* and *M. media*. Among these, the dominating species are *M. foveolata* and *L. minutus* and others are common, except *M. gondwanensis* and *L. badamensis* which are rare and inconsistent.

The six species restricted in their distributions are:

Microbaculispora gondwanensis — Only in the Raniganj Formation.

Microbaculispora barakarensis — Occurs in the Lower Karharbari Formation in traces and exists up to Upper Barakar Formation

Microfoveolatispora raniganjensis — Only in Raniganj Formation. *M. media* — Only in Raniganj Formation.

Didecitriletes horridus — Only in Barren Measure and Raniganj formations.

Imparitriletes korbaensis — In Talchir Formation through Upper Karharbari Formation only.

GENERAL DISCUSSION AND CONCLUSIONS

All the miospore genera grouped in the sub-infraturma Varitrileti are similar in their organization with a longer polar axis, the polar shape and the trilete mark. The only variation observed is in the nature of sculputral elements which helps in distinguishing the genera between themselves. In some genera, the ornament is restricted only to the distal and proximo-equatorial region of the spore surface, e.g. *Microbaculispora*, *Microfoveolatispora*, *Brevitriletes* and *Imparitriletes*. In *Didecitriletes* ornament is present on both the polar faces but of different size and nature. However, in *Lacinitriletes* as redefined here, the exine is laevigate all over. Besides, there are quantitative variations in the morphographic characters, i.e. measurable in arithmatical figures, such as size of the spore, ornamentational processes and number of sculptural elements in unit area or on the *extrema lineamenta*. Such variations have helped in delimiting the species in these genera.

Summarising the results of the above study, the following genera and species have been found to be well-marked in the Varitrileti Group:

Exine baculate:

Genus — *Microbaculispora* Bharadwaj, 1962

M. gondwanensis Bharadwaj, 1962 — Bacula 1 μm broad and 1·5-2 μm high with straight sides and flat heads. Exine ± 1 μm thick.

cf. *M. gondwanensis* — Bacula 1 μm broad and 1·5-2 μm high with straight sides and flat heads. Exine 2-3 μm thick.

M. villosa Bharadwaj, 1962 — Bacula 1 μm broad and 3-4 μm long with straight sides and flat heads. Exine 1 μm thick.

M. barakarensis Tiwari (1965) emend. — Bacula 2·5-3 μm broad and 2-4 μm high with sides slightly narrowed in the middle and broad truncate heads. Exine 1·5-2 μm thick.

M. indica Tiwari (1965) emend. — Bacula 1 μm high and ± 1·5-2 μm broad with sides slightly narrowed in the middle and round to flat head. Exine 1-2 μm thick.

M. tentula Tiwari (1965) — Bacula 1 μm × 1 μm with straight sides and flat heads. Exine ± 1 μm thick.

Exine foveolate:

Genus — *Microfoveolatispora* Bharadwaj, 1962

M. raniganjensis Bharadwaj (1962) emend. — foveolae 2-3 μm in diameter, muri 1-2 μm thick. Exine ± 1 μm thick.

M. foveolata Tiwari (1965) emend. — Foveolae ± 1 μm in diameter, muri less than 0·5 μm thick. Exine ± 1 μm thick.

M. media Bharadwaj, 1962 — Foveolae 1-1·5 μm in diameter, muri ± 1 μm thick. Exine 1 μm thick.

M. bokaroensis Tiwari (1965) — Foveolae ± 1-2 μm in diameter, muri less than 0·5 ±m thick. Exine 2-3 μm thick.

Exine spinose:

Genus — *Didecitriletes* Venkatachala & Kar (1965) emend.

D. horridus Venkatachala & Kar (1965) emend.— Distal spines 1·5-2 μm broad, 2-6 μm long, with broad to bulbous base; proximally coni. Exine ± 1 μm thick.

D. ericianus (Balme & Hennelly) Venkatachala & Kar, 1965 — Distal spines acicular or acuminate, about 2 μm broad, up to 7 μm long; proximally reduced. Exine 1-2 μm thick.

D. dentatus (Balme & Hennelly) Venkatachala & Kar, 1965 — Distal spines 3-4 μm broad, 5-7 μm long; proximally absent. Exine about 2 μm thick.

D. uncinatus (Balme & Hennelly) Venkatachala & Kar, 1965 — Distal spines 1-2 μm broad, 2-8 μm long; proximally absent. Exine ± 2 μm thick.

Exine laevigate:

Genus — *Lacinitriletes* Venkatachala & Kar (1965) emend.

L. badamensis Venkatachala & Kar (1965) emend. — spore size 55-93 μm.

L. minutus Venkatachala & Kar (1968c) emend. — Spore size 22-52 μm.

Exine spinose (*compound spines*):

Genus — *Brevitriletes* Bharadwaj & Srivastava (1969c) emend.

B. communis Bharadwaj & Srivastava (1969c) emend.— Compound spines consisting of basal conical round-headed projection with filiform detachable apical appendage on its apex. Exine 1-2 μm thick.

B. unicus (Tiwari) Bharadw. & Sriv. (1969c) emend. — Compound spines constricted in the middle consisting of lower portion broad and dense with upper narrow and lighter, apex rounded. Exine ± 1 μm thick.

Exine granulose:

Genus — *Imparitriletes* gen. nov.

Imparitriletes korbaensis sp. nov. — Exine distally ornamented with 0·5-1 μm high and 1 μm wide, rounded grana.

The study of distributional pattern from the so far published literature reveals that *Microbaculispora*, *Microfoveolatispora* and *Brevitriletes* are the only genera to be present in the complete sequence, i.e. from Talchir to Raniganj formations, while *Didecitriletes* and *Lacinitriletes* are restricted in their distribution.

Distribution of individual species of the group Varitrileti through different formations of the Lower Gondwana sequence is given in Table 3 and Histogram 1.

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EXPLANATION OF PLATES

(All figures unless otherwise stated are × 750)

PLATE 1

1-6. *Microbaculispora indica* Tiwari (1965) emend.
1. Specimen under normal light, slide no. 5549.
2. Same specimen under DIC showing the nature of ornament on surface and *extrema lineamenta*.
3. A portion of the specimen in fig. 1 enlarged to show marginal bacula. × 1500.
4. Specimen under normal light, slide no. 5551.
5. Same specimen under DIC.
6. A portion of the specimen in fig. 4 enlarged to show the nature of ornament in low focus on surface and on the margin. × 1500.

7-9. *Microbaculispora gondwanensis* Bharadwaj, 1962.
7. A portion of the specimen in fig. 8 enlarged to show the nature of bacula. × 1500.
8. Holotype under normal light.
9. Same specimen under DIC to evaluate the nature of bacula.

PLATE 2

10, 11. *Microbaculispora barakarensis* Tiwari (1965) emend.
10. Specimen under normal light.
11. Holotype under normal light.
12, 13. *Microbaculispora* sp. cf. *M. gondwanensis* Bharadwaj, 1962.
12. Specimen under normal light, Slide no. 5557.
13. Same specimen under DIC.
14-16. *Microbaculispora tentula* Tiwari, 1965.
14. Specimen under normal light, slide no. 5560.
15. Same specimen under DIC.
16. A portion of specimen in Pl. 3, fig. 27 enlarged to show distributional pattern of bacula. × 2000. Slide no. 5554.
17. *Microbaculispora indica* Tiwari (1965) emend., Holotype under normal light.

PLATE 3

18-21. *Microbaculispora barakarensis* Tiwari (1965) emend.
18. Specimen under normal light, slide no. 5549.
19. Same specimen under DIC.
20. A portion of specimen in fig. 18 enlarged to show bacula in low focus. × 1500.
21. A marginal portion of the same specimen enlarged. × 1500.
22, 26, 27. *Microbaculispora tentula* Tiwari, 1965.
22. Sublaterally pressed specimen under normal light, slide no. 5559.
26. Specimen under normal light focussed to show marginal bacula, slide no. 5558.
27. Laterally preserved specimen under normal light, slide no. 5554.
23-25. *Microfoveolatispora foveolata* Tiwari (1965) emend.
23. Specimen under normal light.
24. Same specimen under DIC.
25. A portion of the same specimen enlarged to show foveolae in surface view. × 1500.

PLATE 4

28, 29. *Microbaculispora villosa* (Balme & Hennelly) Bharadwaj, 1962.
28. Specimen in proximal focus under normal light.
29. Same specimen under DIC.
30. *Microbaculispora* sp. cf. *M. gondwanensis* Bharadwaj, 1962. Specimen under DIC, slide no. 5556.
31-35. *Microfoveolatispora media* Bharadwaj, 1969.
31. Specimen in proximal view under normal light.
32. Same specimen in distal view under normal light.
33. A portion of the same specimen enlarged to show the nature of foveolae in surface view. × 1500.
34, 35. Same specimen under DIC in two foci.

PLATE 5

36-38. *Microfoveolatispora bokaroensis* Tiwari, 1965. Specimens under normal light showing variations in the nature of Y-mark, slide nos. 5579, 5570, 5570.
39, 40. *Microfoveolatispora media* Bharadwaj, 1969. Specimen in distal and proximal foci respectively.
41, 42. *Microfoveolatispora raniganjensis* Bharadwaj, 1962; Specimen under normal light and DIC respectively.

PLATE 6

43-47. *Microfoveolatispora raniganjensis* Bharadwaj, 1962.
43, 44. Specimen under normal light in proximal and distal view, slide no. 5576.
45. Same specimen under DIC.
46. Holotype under normal light.
47. A specimen under normal light.
48. *M. bokaroensis* Tiwari, 1965 — A specimen under normal light, slide no. 5581.

PLATE 7

49-55. *Didecitriletes horridus* Venkatachala & Kar (1965) emend.
49, 50. Laterally flattened specimen under normal light and DIC showing distribution of spines on both the faces.
51. A sublaterally flattened specimen under DIC.
52, 53. Holotype in proximal and distal foci respectively under normal light.
54. Same specimen under DIC.
55. A portion of the same specimen enlarged to reveal the nature of spines on distal surface and margin. × 1500.

PLATE 8

56-60. *Didecitriletes horridus* (Contd)
56. Specimen under DIC.
57. Semilaterally specimen under normal light.
58. A portion of the specimen in fig. 57 enlarged to show the marginal spines in the form of stumps. × 1500.
59. A specimen under DIC.
60. A portion of the same specimen under normal light enlarged to show spines. × 1500.
61. '*Didecitriletes bellus*' Venkatachala & Kar, Holotype (slide no. 2489) under normal light.
62-65. *Lacinitriletes minutus* Venkatachala & Kar (1968) emend.
62, 63. Specimens under normal light.
64, 65. Holotype (slide no. 2435) under normal light and DIC respectively.

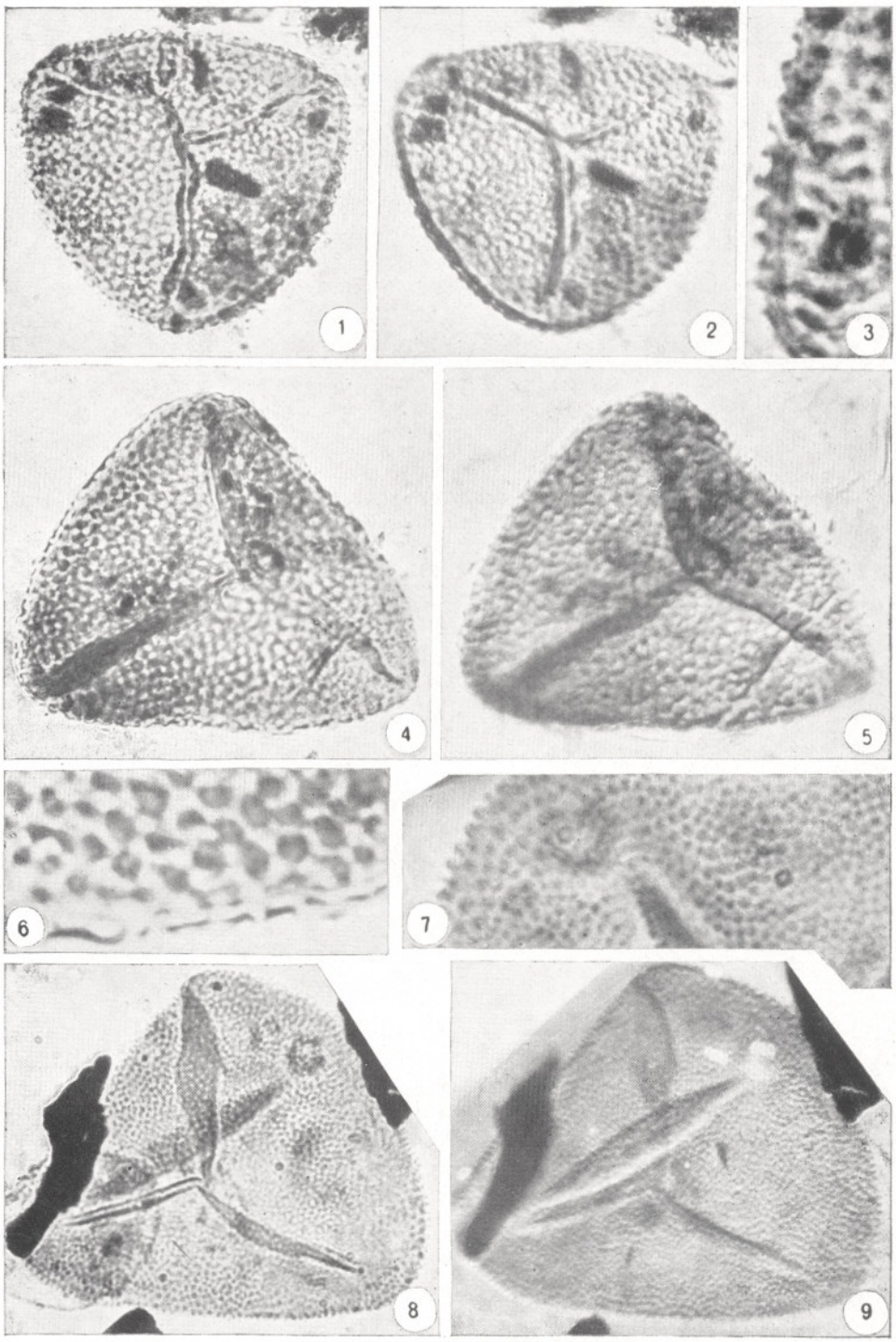
PLATE 9

66-69, 78-80. *Brevitriletes unicus* (Tiwari) Bharadwaj & Srivastava (1969) emend.
66, 67. A specimen under normal light and DIC, slide no. 5716.
68. A specimen under normal light, slide no. 5718.

69. A portion of a specimen in fig. 68 enlarged to reveal the nature of spines, slide no. 5521. × 2000.
71-73. *Lacinitriletes badamensis* Venkatachala & Kar (1965) emend.
71. Holotype of *Psilalacinites triangularis* Kar under normal light.
72. A portion of the same specimen enlarged to show laevigate nature of exine. × 1500.
73. A specimen under normal light, slide no. 2435/8.
74, 75. *L. minutus* — specimens under normal light.
70, 76, 77. *Brevitriletes communis* Bharadwaj & Srivastava (1969) emend.— specimens under normal light, slide nos. 5716, 5712 and 5713.
78, 79. *B. unicus* (Tiwari) Bharadwaj & Srivastava (1969) emend.— specimens under normal light and DIC, slide no. 5717.
80. A specimen under normal light, slide no. 5711.

PLATE 10

81, 82. *Brevitriletes communis.*
83, 85. *Imparitriletes korbaensis* gen. et sp. nov. 85. Holotype, slide no. 5723.
84. *Brevitriletes unicus* — a specimen under normal light, slide no. 5551.
86, 91, 100. *B. jhingurdahiensis* Sinha, 1972 — 86. holotype, slide no. 4102 showing contact areas.
87, 88. *B. communis* specimens under normal light and DIC, slide nos. 5713, 5715.
99. A portion of the specimen in fig. 81 enlarged to reveal the nature of spine. × 2000.
89. Holotype of *Brevitriletes crassus* Sinha, 1972, slide no. 4102.
90, 92-98, 101-103. *Imparitriletes korbaensis* sp. nov. Specimens showing variations in the nature of Y-mark and the grana, slide nos. 5722, 5721, 5724, 5719, 5723, 5720, 5725.



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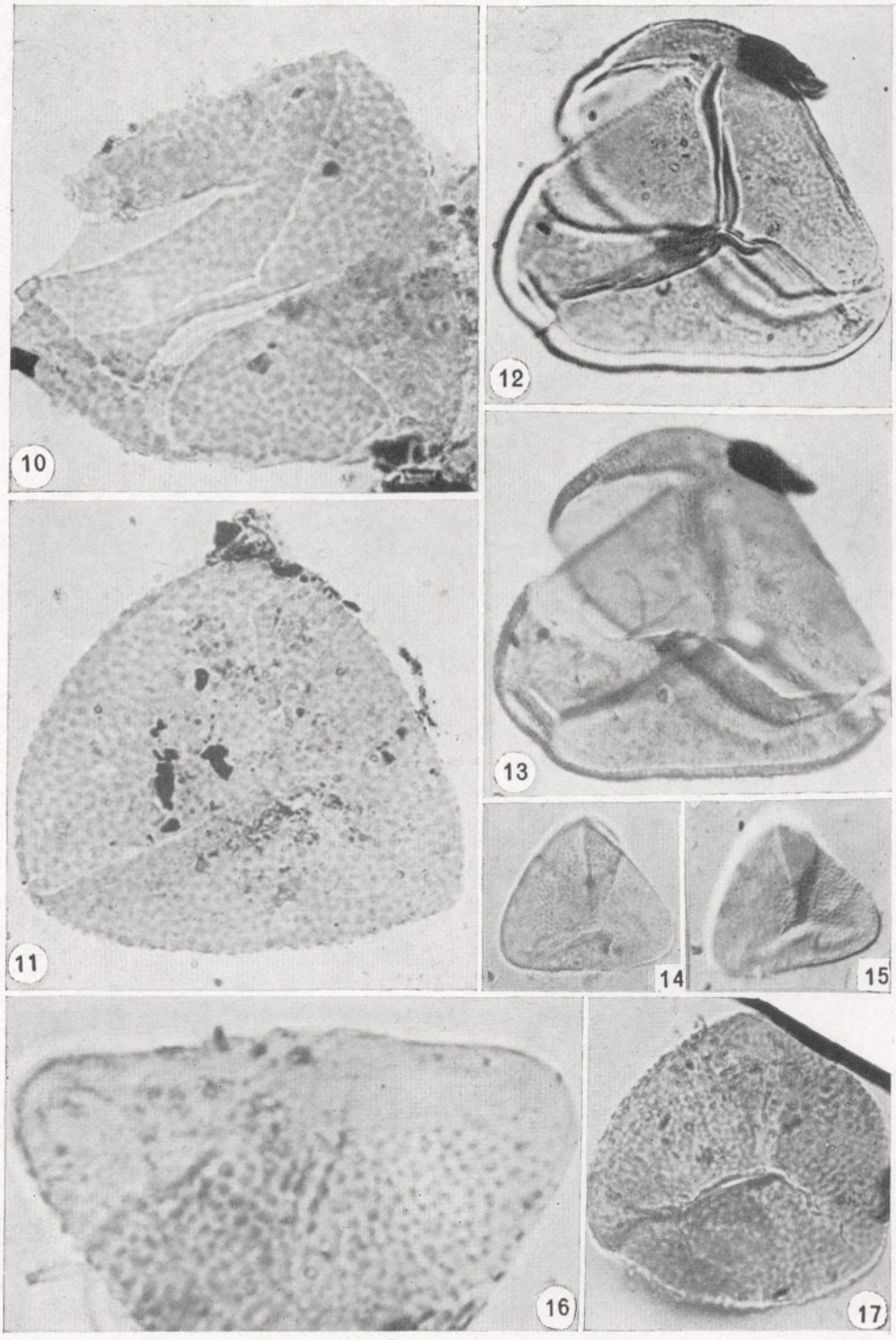

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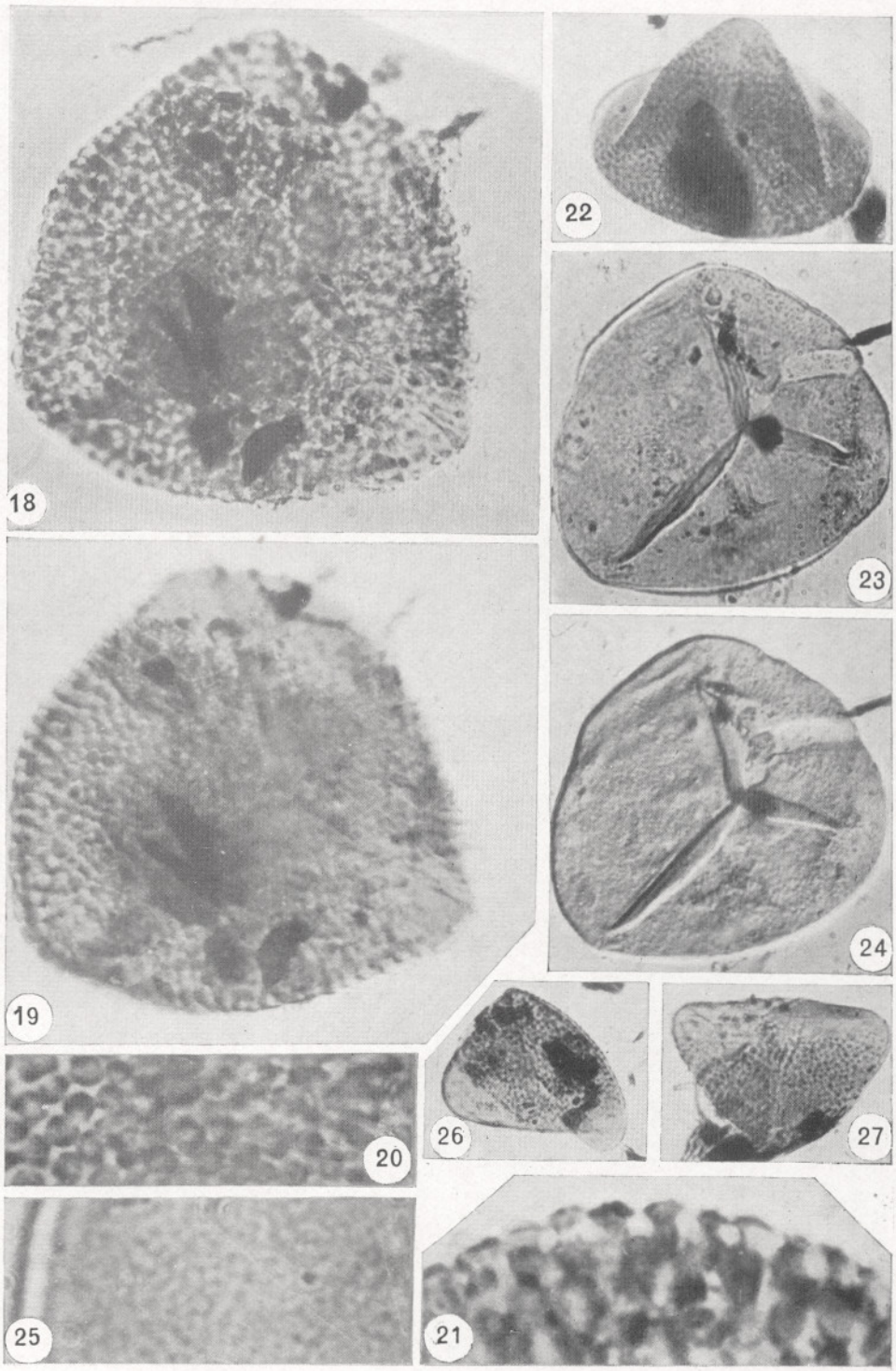

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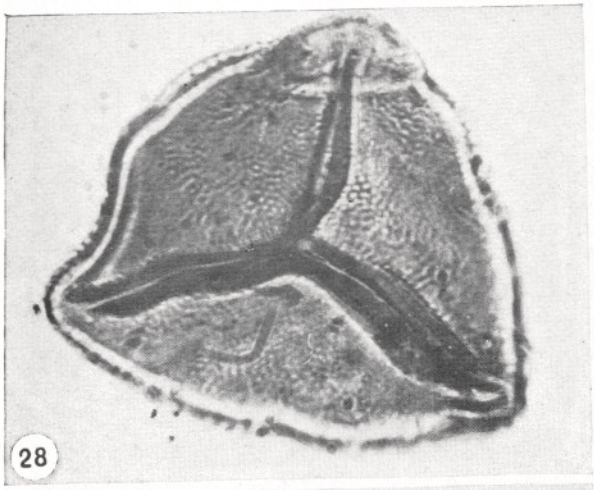

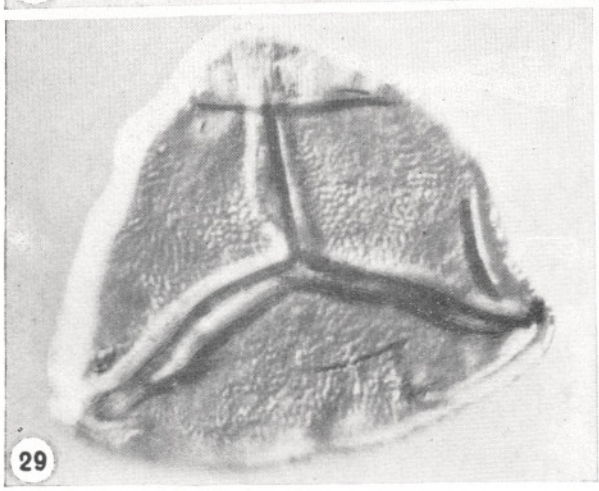

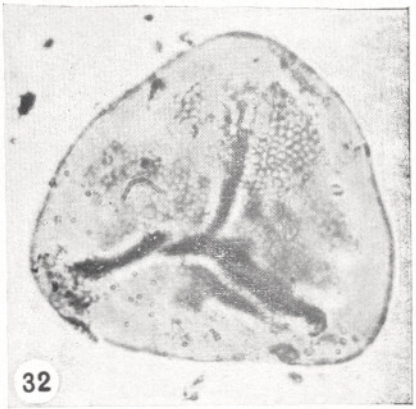

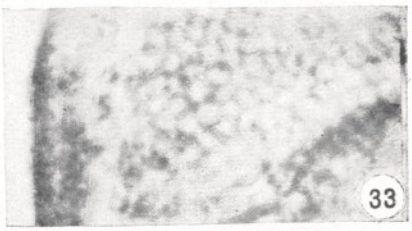

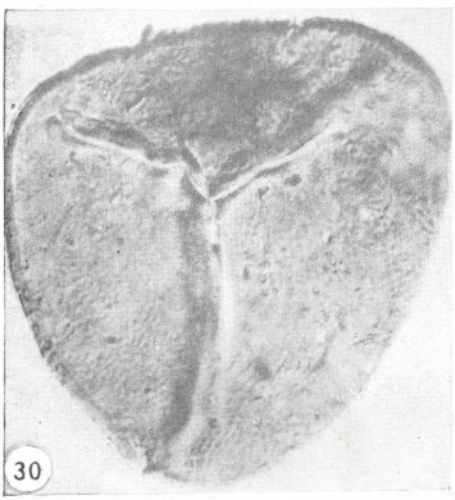

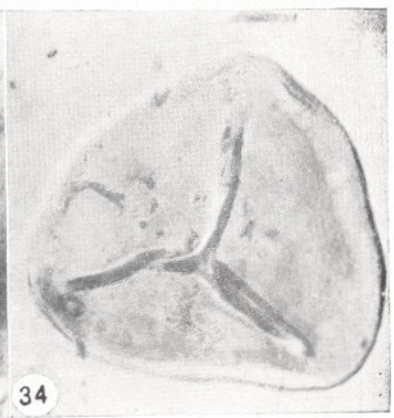

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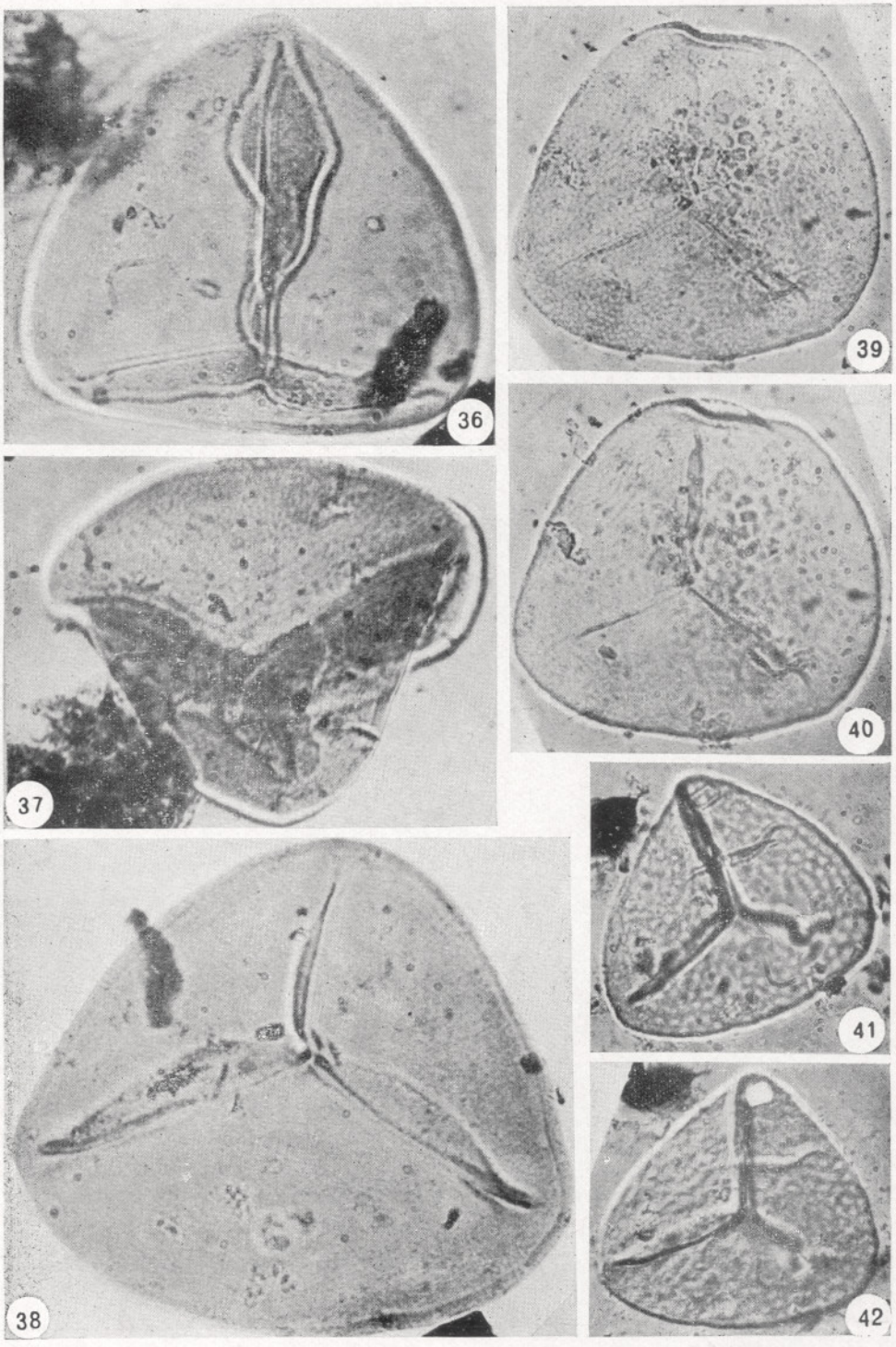

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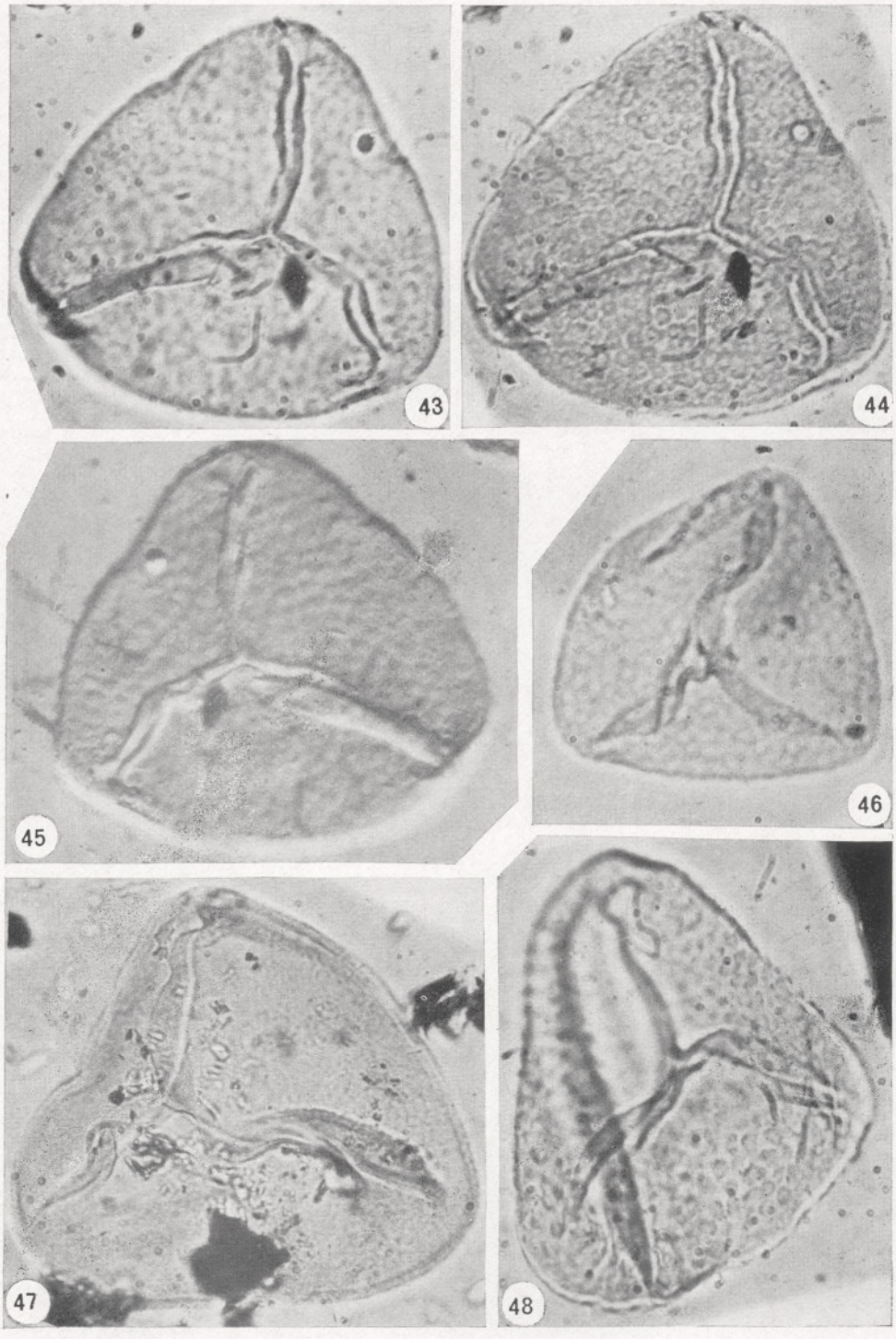

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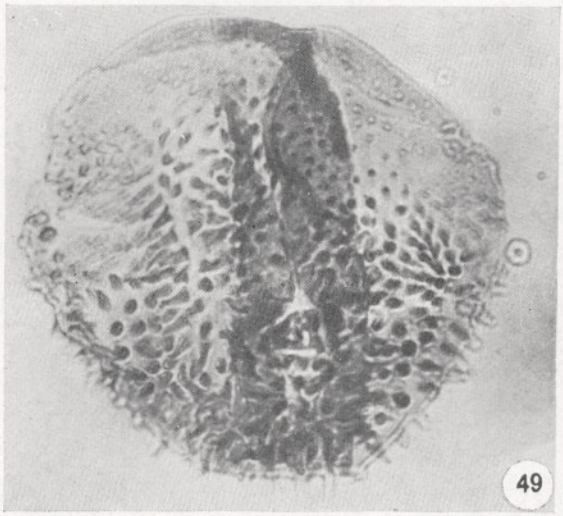

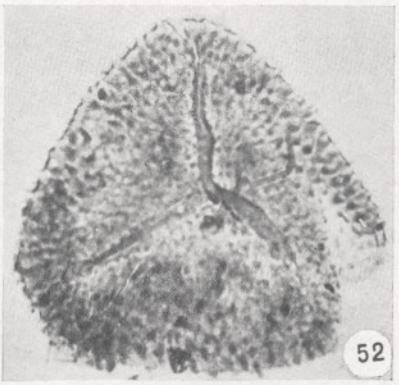

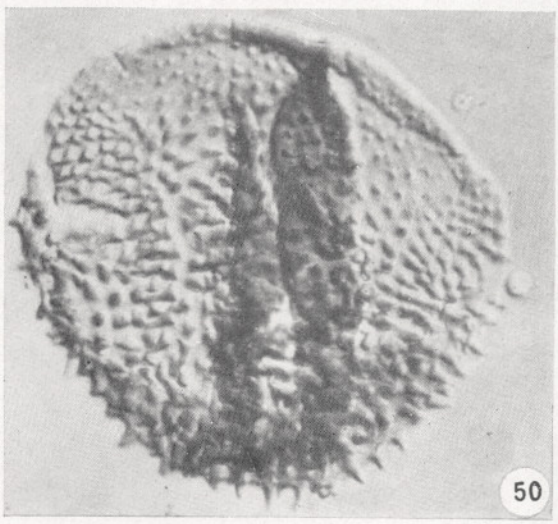

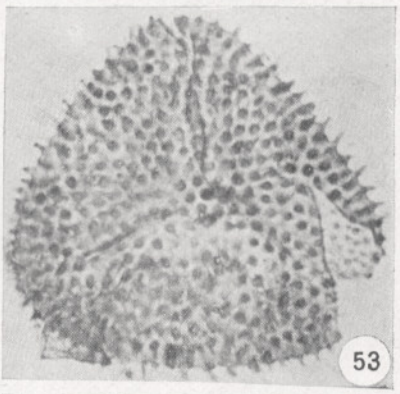

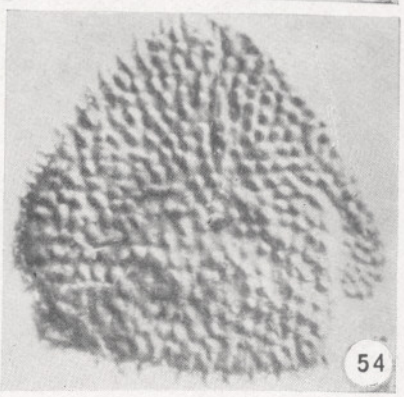

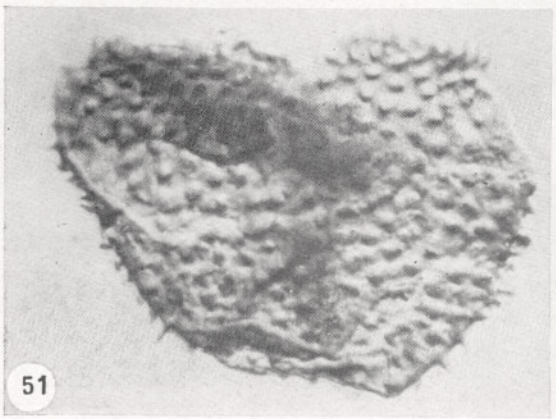

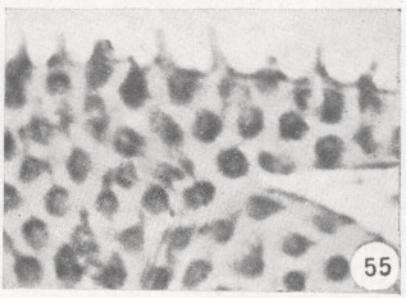

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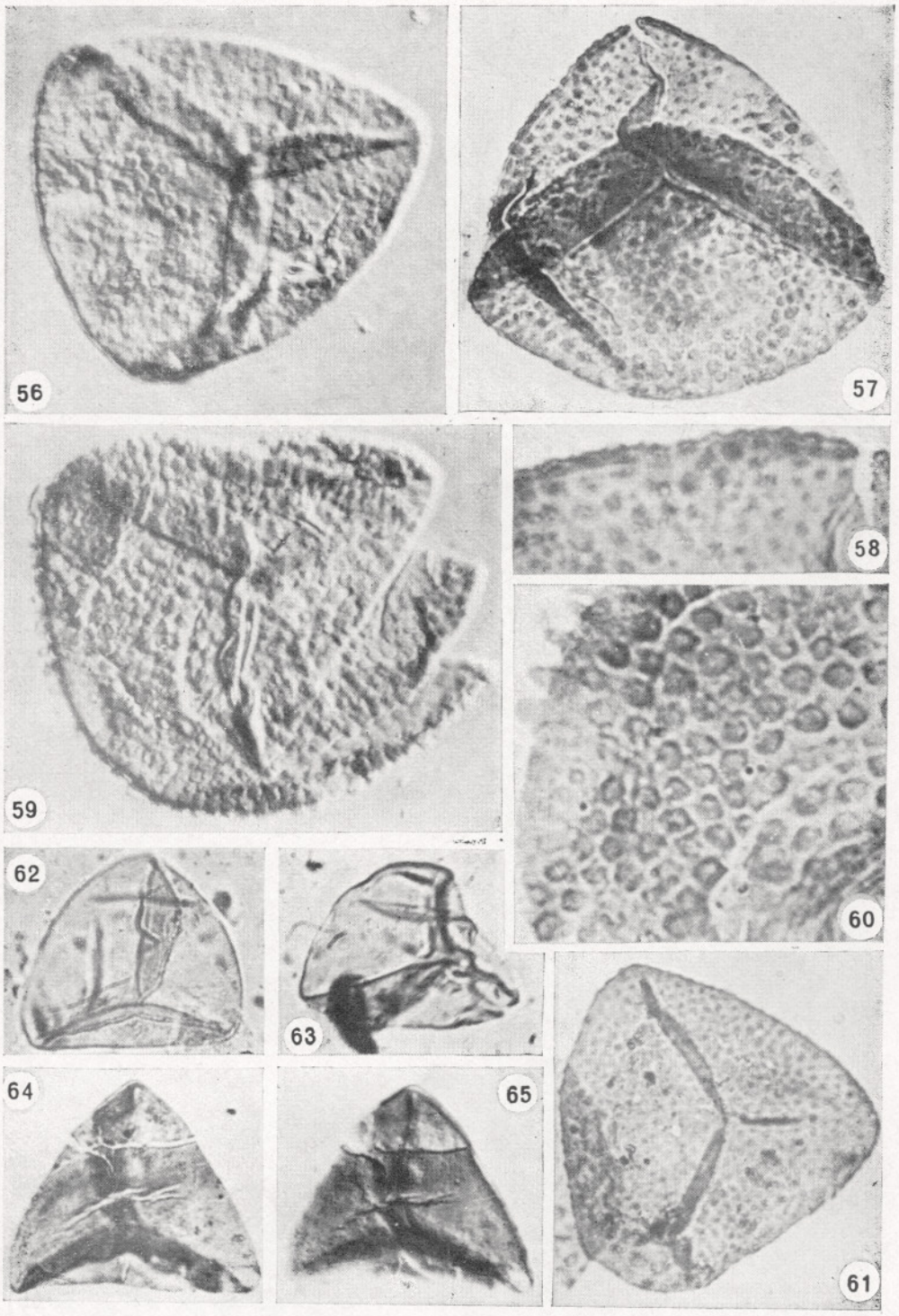

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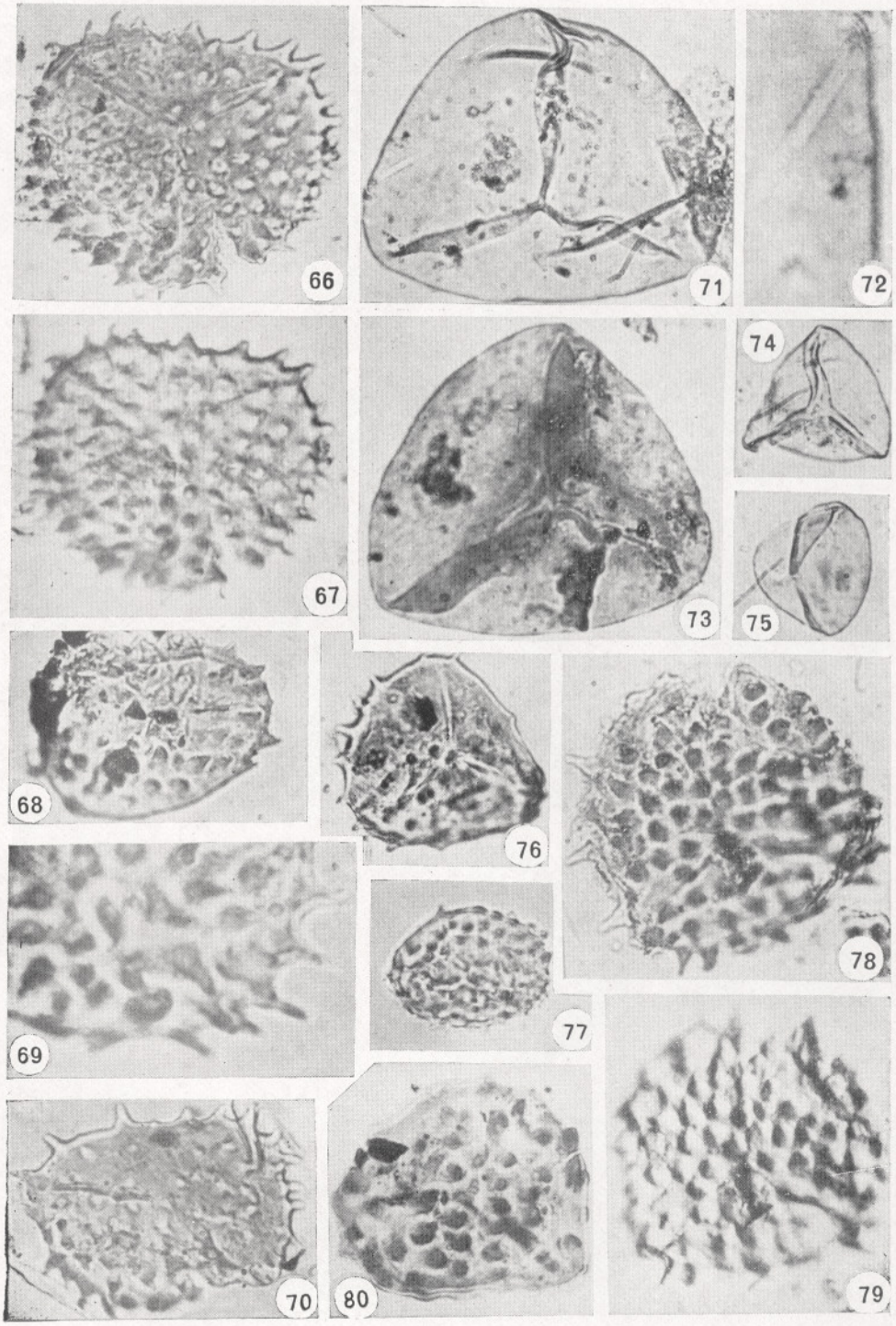

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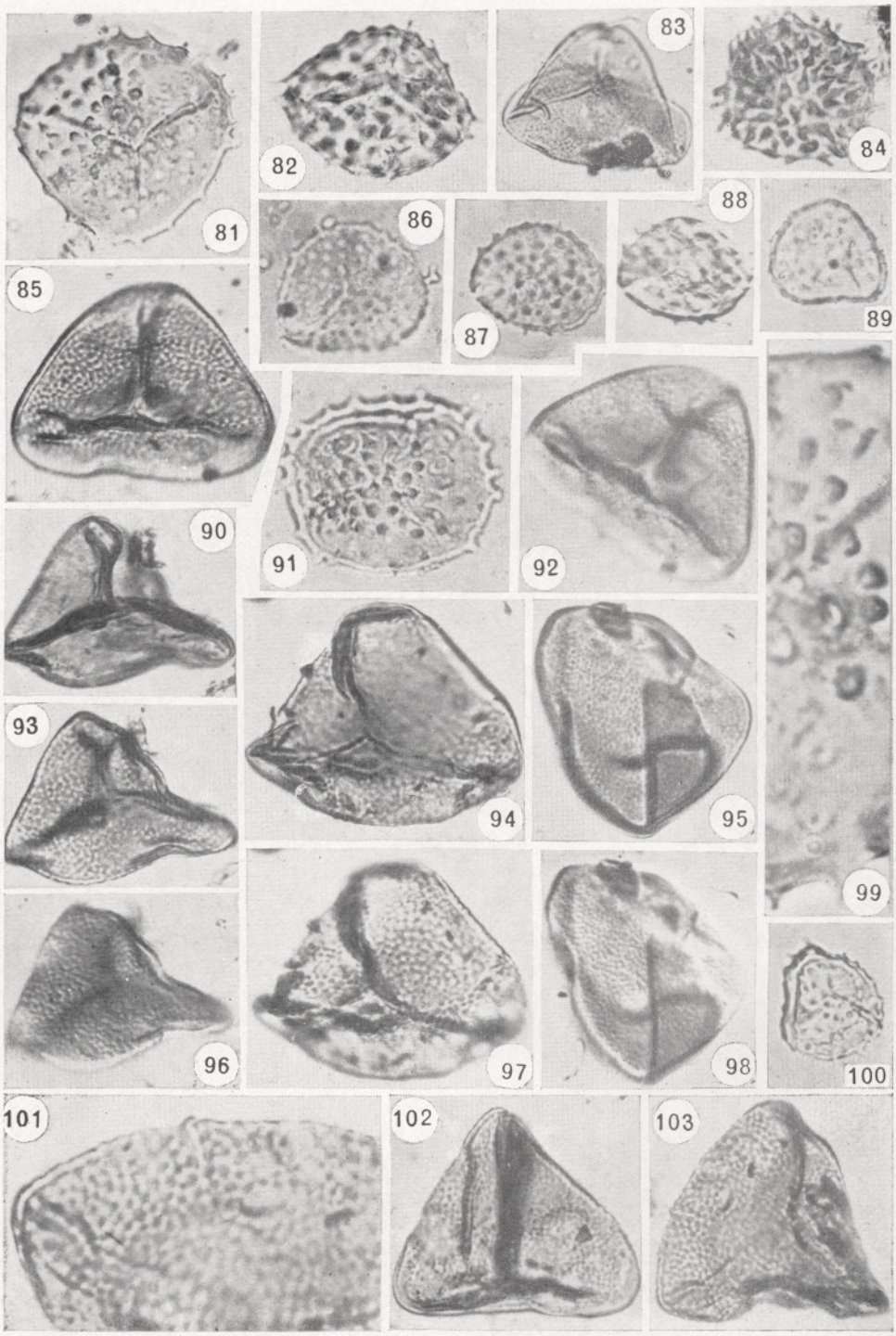
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PLATE 10