

Megaspores from Early Permian of India

Rajni Tewari & Hari K. Maheshwari

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

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Fourteen species of megaspores are reported from the basal Barakar (Karharbari) Formation (Early Permian) exposed in Birsinghpur Pali, Mohpani, Giridih and Hutar coalfields. Four species are new. The genera *Srivastavaesporites*, *Bulbosia* and *Verrubacuriletes* are considered to be junior synonyms, respectively of *Banksisporites*, *Biharisporites* and *Jhariatrilletes*. New species belong to the genera *Duosporites*, *Barakarella* and *Jhariatrilletes*.

Key-words - Megaspores, Gondwana, Early Permian, India.

INTRODUCTION

Early works on dispersed megaspores recovered from the Permian Gondwana of India (Mehta, 1943- from Singrauli Coalfield; Ghosh & Sen, 1948- from Raniganj Coalfield; Pant 1950- from Talcher Coalfield; Trivedi, 1953 - from Singrauli Coalfield, Tripathi, 1952 - from Umaria Coalfield; Goswami, 1956 - from Burhar Coalfield; and Surange, Singh & Srivastava, 1953 - from the West Bokaro Coalfield) grouped the megaspores under the genus *Triteltes* (Reinsch) Schopf and referred some of them to the species described from the Carboniferous of the Northern Hemisphere. Srivastava (1954) gave new names to such species and also instituted some new species. Potonic (1954) referred two of the species described by Surange *et al.* (1953) to the new genera *Singhisporites* and *Biharisporites*.

Høeg, Bose and Manum (1955) were the first to reveal the presence of "cushions", "pits" or "nipples" on the mesosporium of inner body of Permian megaspores from Zaire. These authors instituted the genus *Duosporites* for such megaspores and emphasized the importance of mesosporium for the circumscription of genera and species.

An important contribution to the study of megaspores was made by Pant and Srivastava (1961, 1962, 1964). They studied the megaspores, both morphographically and structurally in dry and wet conditions, respectively. The circumscription of the species described by these authors was mainly based on the nature of different exine layers.

Bharadwaj and Tiwari (1970) made an extensive study of the megaspores from Permian Gondwana of India, supplemented by known account of megaspores from other Gondwana continents. During the last two decades additions have been made to our knowledge on megaspores from the "Middle" Permian (Pant & Mishra, 1986), Latest Permian (Pant & Basu, 1979), Early Triassic (Maheshwari

& Banerji, 1975), Late Triassic (Banerji, Kumaran & Maheshwari, 1978), and Late Jurassic-Early Cretaceous (Banerji, Jana & Maheshwari, 1984). Maheshwari and Tewari (1988) have recently evaluated biostratigraphic significance of megaspores in context of the Indian Gondwana.

MATERIAL AND METHODS

Megaspores investigated were recovered from samples collected from (i) Giridih Coalfield (Bihar), Central Pit in Srirampur Area (Map 1); (ii) Hutar Coalfield (Bihar), from the traverses along Koel River (north side), Deori Nala (south side) and at confluence of Deori-Ghorasumi Nala (Map 2); (iii) Birsinghpur Pali Coalfield (Madhya Pradesh), from a section exposed near the Ganjra Nala - Johilla River confluence (Map 3) and (iv) Mohpani Coalfield (Madhya Pradesh), from the exposures in the Sitarewa River, east of Mohpani Village (Map 4). The rock samples are grey to dark grey carbonaceous shales. Megaspores earlier described from Katri Nala, Jharia Coalfield (Map 5) were restudied.

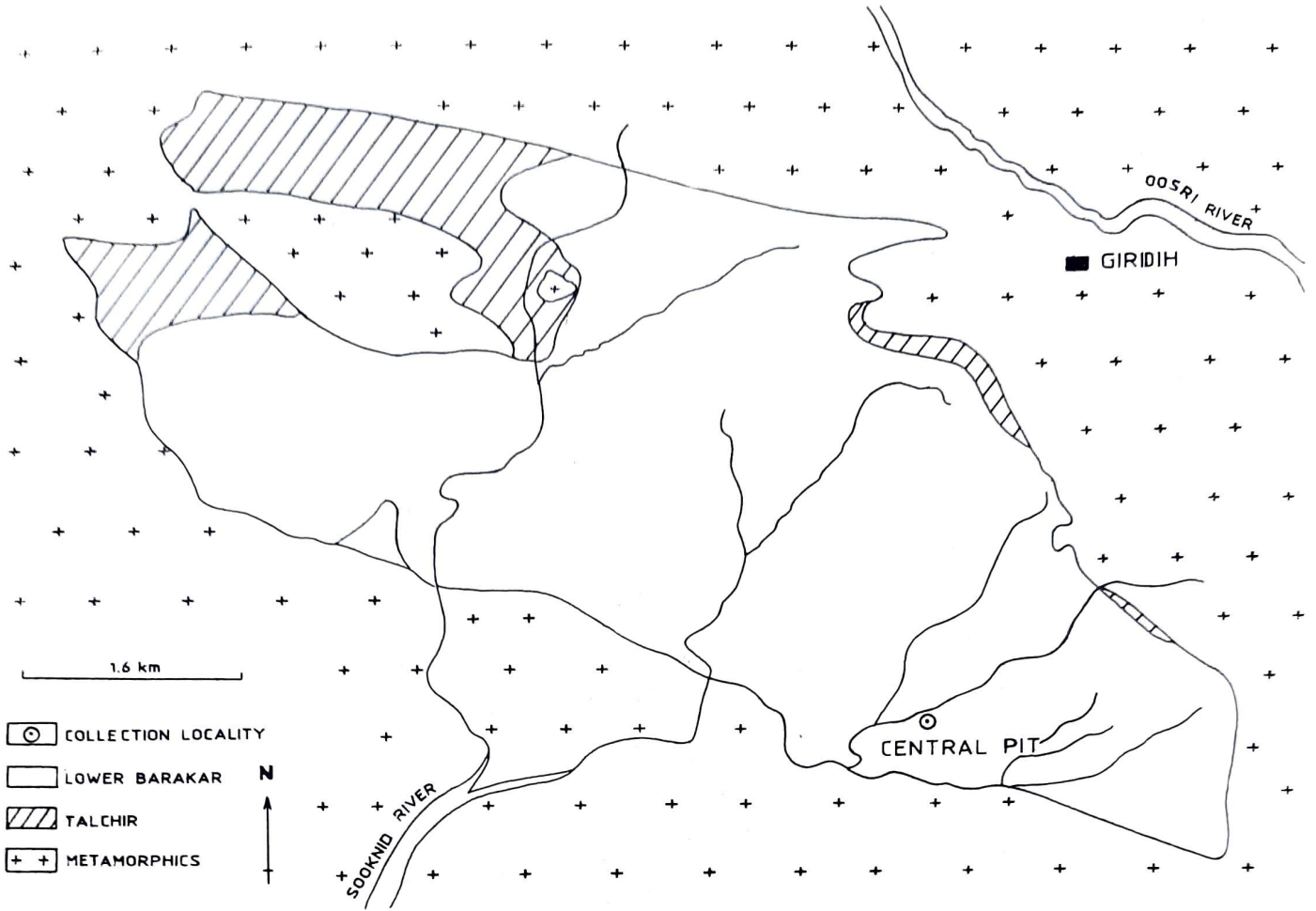
The material was processed for the study of megaspores as outlined in Maheshwari and Bajpai (1984), and others.

DESCRIPTION

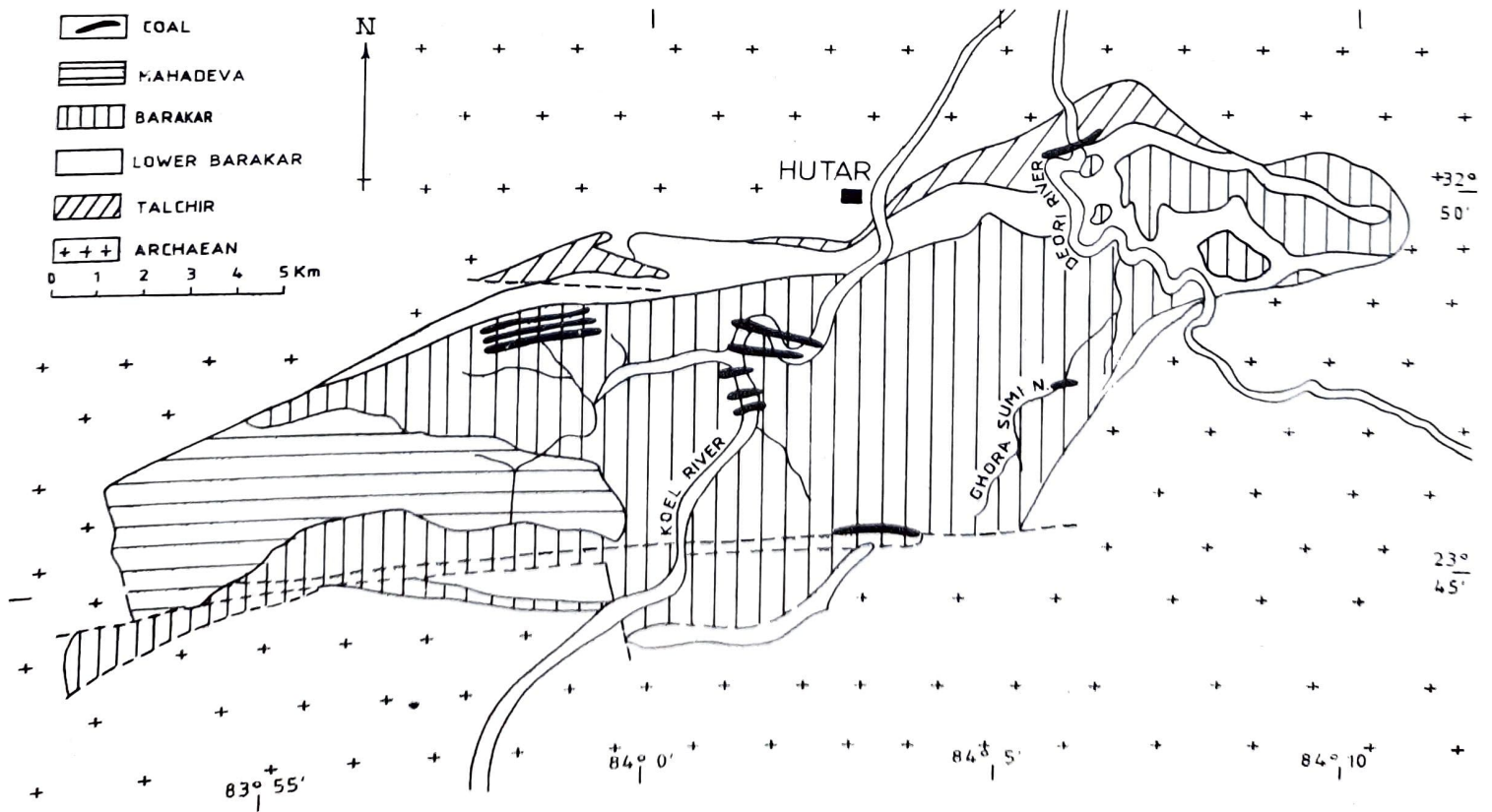
Genus -*Bokarosporites* Bharadwaj & Tiwari 1970

Type species - *Bokarosporites psilatus* Bharadwaj & Tiwari 1970

Remarks - According to Bharadwaj and Tiwari (1970), the contact area in most of the specimens is not conspicuous; in others, where visible is without marked boundaries. In the specimens described presently, distinct boundaries of contact area are visible.



Map 1



Map 2

Bokarosporites rotundus (Singh 1953) Bharadwaj & Tiwari 1970

Pl. 1, figs 1-2; Pl. 6, figs 4,6

1953 *Triletes rotundus* Singh

1956 *Triletes* (al. *Triletes*) *rotundus* (Singh in Sur., Singh & Sriv. 1953, 5,12, Taf. 2 fig 9) Potonic

1970 *Bokarosporites rotundus* (Singh) Bharadwaj & Tiwari

Neotype - Pl. 1, fig. 2, slide no. 2236, Birbal Sahni Institute of Palaeobotany, Lucknow; Kulti Formation, Katri Nala section near Dhanbad, Jharia Coalfield, Bihar.

Singh (1953, p. 12) did not designate a holotype for *Triletes rotundus*. However, as he illustrated only one specimen, under Article 7.5 of the International Code of Botanical Nomenclature (Greuter, 1988), this specimen should have been designated as a lectotype (and not as holotype *vide* Bharadwaj & Tiwari, 1970, p. 21). However, neither the specimen illustrated by Singh (1953, pl. 2, fig. 9) nor his original material is traceable and as such a Neotype has been designated here.

Description - Megaspores trilete, azonate, more or less circular in proximo-distal view. Tri-radiate ridges almost straight, up to 3/4 spore radius long, ending up near arcuate ridges, the latter being distinctly marked. Exosporium psilate, appearing scabrate in wet condition. Differential maceration in HNO₃ and KOH reveals thin, transparent, spherical, much folded, scabrate or smooth, colourless or light brown mesosporium, apparently without cushions.

Distribution - *Karharbari "Formation"* - Hutar Coalfield (present study), Johilla Coalfield (Bharadwaj & Tiwari, 1970), Mohpani Coalfield (Bharadwaj & Tiwari, 1970); *Barakar Formation* - Bokaro Coalfield (Singh, 1953; Bharadwaj & Tiwari, 1970), South Karanpura Coalfield (Bharadwaj & Tiwari, 1970), Talcher, Singrauli and Korba coalfields (Bharadwaj & Tiwari, 1970); *Kulti Formation* - Jharia Coalfield (present study).

Genus - *Talchirella* Pant & Srivastava 1961 emend. Bharadwaj & Tiwari 1970

1962 *Carruthersiella* Pant & Srivastava

1968 *Trilaevipellites* Kar

1968 *Pantiasporites* Kar

Type species - *Talchirella trivedii* Pant & Srivastava 1961

Extended Diagnosis - Megaspores trilete, ± circular in proximo-distal orientation, tri-radiate ridges almost straight, mostly ending before spore equator, usually limited towards periphery by well-defined, strongly developed arcuate ridges which delimit the three contact facets; sporoderm two-layered, outer exosporium usually with small grana or verrucae; inner mesosporium originally globular, acquiring various shapes due to folding in mounted specimens, separate from exosporium all over except at proximal pole where attached at inter-radial areas through a series of

variously distributed projections (cushions/nipples of authors).

Remarks - Eversince the genus *Talchirella* was instituted by Pant and Srivastava (1961) there has been a controversy about its organization. The authors of the genus are of the view that the megaspore has three wall layers - the outer exosporium which is papillate, the middle mesosporium and the inner endosporium. Bharadwaj and Tiwari (1970), however, found only two layers - the outer exosporium and the inner mesosporium. The exosporium is ornamented and the mesosporium forms an inner sac-like structure bearing cushions. According to them, during controlled chemical processing, the surface sculpture disappears and an unornamented exine with rough appearance remains. This has been considered as the "middle layer" by Pant and Srivastava while actually there is no such layer. Pant and Srivastava described the ornamentation of exine as papillate; Bharadwaj and Tiwari describe the same as verrucate. Unfortunately, the slides of the species described by these authors are not available for re-examination. However, what appears from the photographs and text-figures of the various species of *Talchirella* proves that neither of the species, in true sense, is verrucate or papillate; instead, they appear rough or finely granulate on the surface. Since the emended diagnosis given by Bharadwaj and Tiwari (1970) does not provide in detail all the characters that are important to define the genus, it was necessary to give an enlarged diagnosis. The genera *Carruthersiella* Pant & Srivastava 1962 and *Pantiasporites* Kar 1968 have already been merged by Bharadwaj and Tiwari (1970) with the genus *Talchirella*. It was also necessary to merge the other genus *Trilaevipellites* Kar 1968 with it. For the purpose of speciation certain characters mentioned below have been taken into account.

1. Shape - Circular (oval, circulo-triangular, subcircular).
2. Presence of distinct straight or sinuous triradiate ridges. They may be uniformly broad throughout, tapering at the ends or slightly broad near arcuate ridges.
3. Presence of distinct arcuate ridges.
4. Presence of inner body which may be circular (circulo-triangular) or triangular with many cushions or one row of cushions which may be arranged trigonally, irregularly or forming a border around faintly visible trilete mark, respectively.

Talchirella nitens (Dijkstra 1955) Bharadwaj & Tiwari 1970 emend.

Pl. 1, figs 5, 8, 11

1955 *Triletes nitens* Dijkstra

1962 *Duosporites nitens* (Dijkstra) Pant & Srivastava

1968 *Trilaevipellites psilatus* Kar

1968 *Duosporites nitens* (Dijkstra) Pant & Srivastava

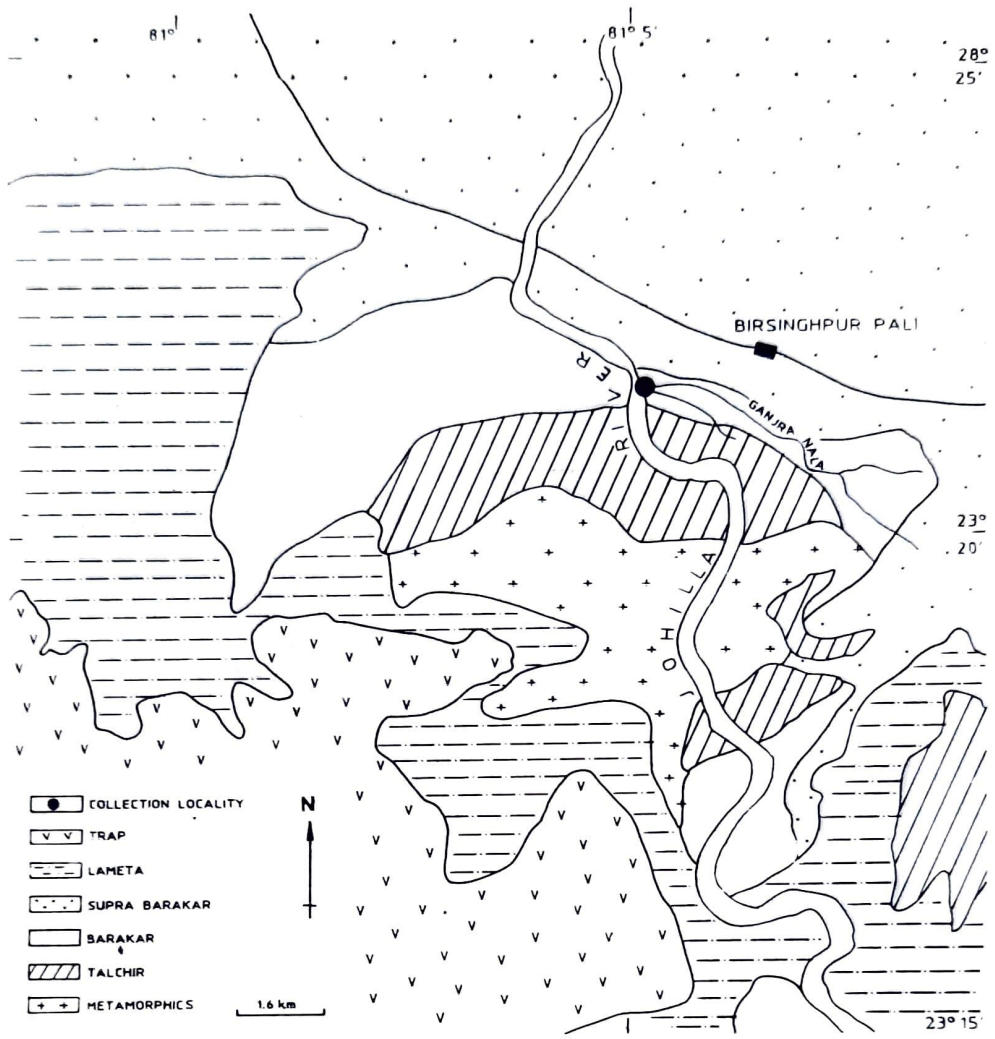
1970 *Trilaevipellites psilatus* Kar emend. Bharadwaj & Tiwari

1970 *Talchirella sparsa* Bharadwaj & Tiwari

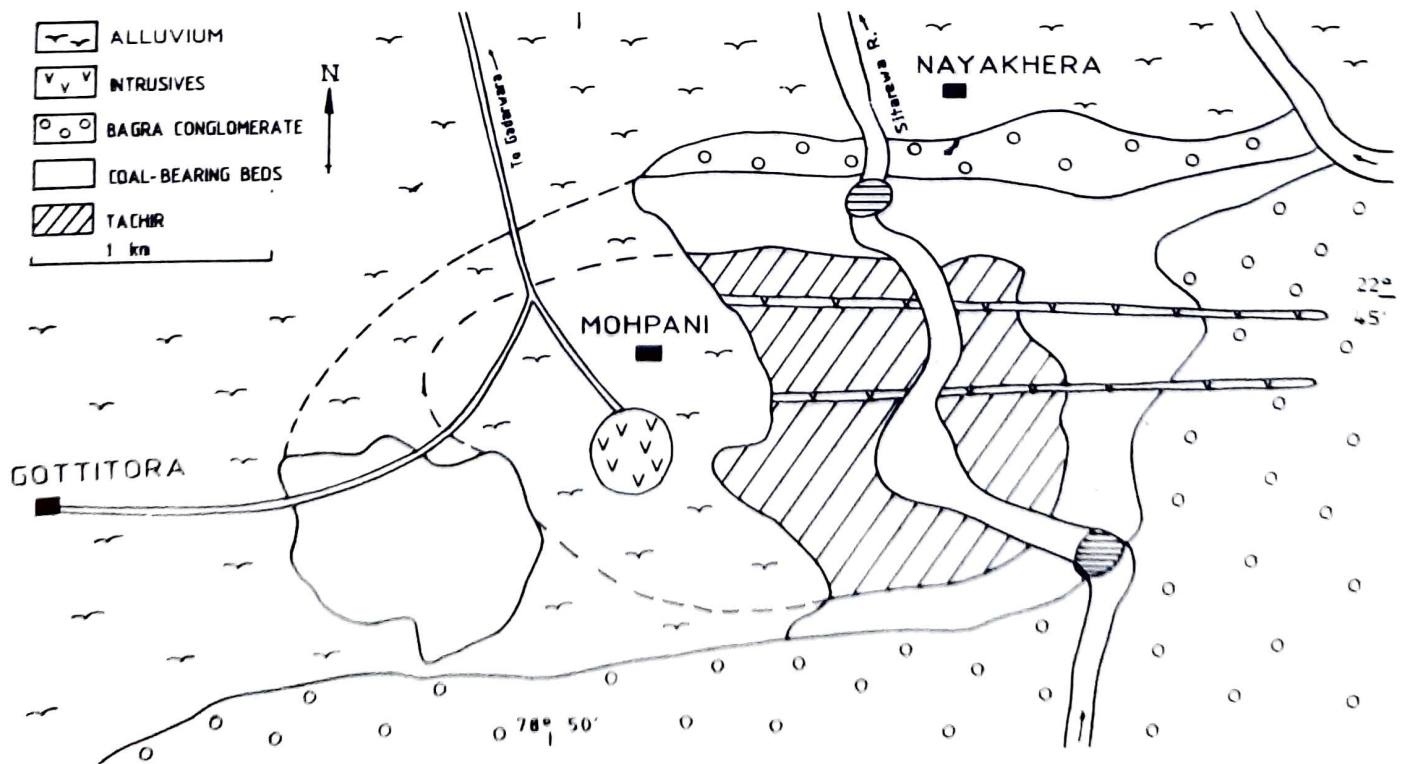
1970 *Talchirella raniganjensis* Bharadwaj & Tiwari

1974 *Trilaevipellites talchirensis* Lele & Chandra

1983 *Talchirella raniganjensis* Bharadwaj & Tiwari, 1970 : Lele &



Map 3



Map 4

Srivastava

Emended diagnosis - Megaspores trilete, azonate, circular in proximodistal view; tri-radiate ridges straight to wavy, about 3/4 spore radius long, may be uniformly broad throughout, or narrow or broad towards distal end, meeting arcuate ridges, latter distinctly marked; sporoderm two-layered; outer exosporium microverrucate; inner mesosporium thin, transparent, spherical, showing biserially arranged cushions around tri-radiate mark.

Remarks - Bharadwaj and Tiwari (1970) described three species, viz., *Talchirella nitens*, *T. sparsa* and *T. raniganjensis* with more or less same characteristics. The three species are being merged here since the nature of tri-radiate ridges, whether straight or sinuous, tapering or broad towards ends, or uniform throughout is a preservational factor. Same is the case with the contact ridges. Likewise, the arrangement of cushions inside the inner body in different species is also apparently similar since the cushions in all the three species are biserially arranged, i.e., one row of cushions on either side of tri-radiate mark. Sometimes, the cushions may appear to be irregularly arranged. This may be due to folding of inner body. *Trilaevipellites psilatus* (Kar, 1968, pl. 1, figs 3,4) and *T. talchirensis* (Lele & Chandra, 1974, pl. 1, figs 1-6) have been merged here on the basis of similarity of arrangement of cushions inside the inner body. Exosporium, however, has been reported as \pm laevigate in *T. psilatus*. Since the megaspore was not photographed in dry condition, it is difficult to say if the megaspore actually was laevigate in dry condition.

Distribution - *Karharbari "Formation"* - Mohpani Coalfield (present study); *Barakar Formation* - Korba Coalfield (Bharadwaj & Tiwari, 1970); *Kulti Formation* - Jharia Coalfield (Kar, 1968); *Raniganj Formation* - Raniganj Coalfield (Bharadwaj & Tiwari, 1970), and *Lower Gondwana* - Rio Grande do sul, Central Coal washery in Capifera, Santa Catarina Coalfield, Brazil (Dijkstra, 1955; Pant & Srivastava, 1962).

Talchirella trivedii Pant & Srivastava 1961 emend.
Bharadwaj & Tiwari 1970

Pl. 1, figs 4,6-7, 9, 10; Pl. 2, figs 1-2; Pl. 6, figs 2-3, 5,8

1961 *Talchirella trivedii* Pant & Srivastava
1970 *Talchirella trivedii* (Pant & Sriv.) emend. Bharadwaj & Tiwari
1983 *Trilaevipellites multipulvinatus* Lele & Srivastava
1983 *Talchirella media* Lele & Srivastava

Description - Megaspores trilete, azonate, circular or triangular in outline in proximo-distal view. Tri-radiate ridges straight to wavy, up to 3/4 spore radius long, ending up near arcuate ridges, latter distinctly marked. Exosporium verrucate. Differential maceration in HNO₃ and KOH reveals thin, transparent, circular inner body showing large number of cushions arranged trigonally around faintly visible mark.

Remarks - *Trilaevipellites multipulvinatus* (Lele &

Srivastava, 1983, pl. 1, figs 1,2; text-fig. 2) has been merged here due to similarity in arrangement of cushions.

Talchirella media (Lele & Srivastava, 1983, pl. 2, figs 16,17) has been merged here since the inner body has trigonally, and not irregularly, arranged cushions.

Distribution - *Karharbari "Formation"* - Giridih and Hutar coalfields (present study), Johilla Coalfield (Pant & Mishra, 1986), Johilla and Mohpani coalfields (present study); *Barakar Formation* - Raniganj Coalfield (Lele & Srivastava, 1983), Sohagpur, North Korba and Chirimiri coalfields (Bharadwaj & Tiwari, 1970), Talcher Coalfield (Pant & Srivastava, 1961).

Talchirella flavata (Kar 1968) Bharadwaj & Tiwari 1970
emend.
Pl. 2, figs 3-5

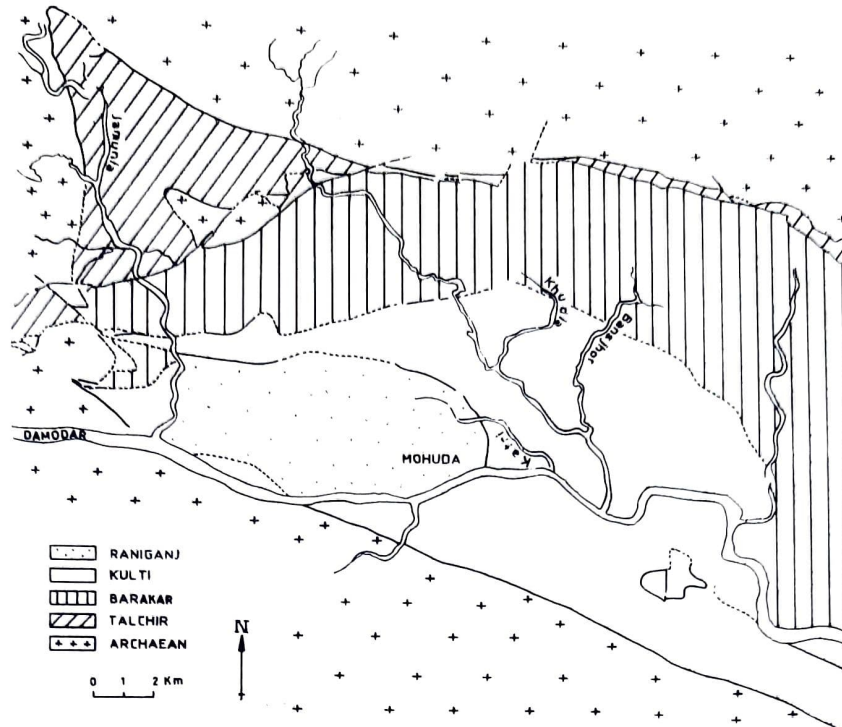
1968 *Pantiasporites flavatus* Kar
1968 *Duosporites vulgatus* (Dijkstra) Pant & Srivastava
1970 *Talchirella vulgata* (Dijks.) Bharadwaj & Tiwari
1970 *Talchirella notabilis* Bharadwaj & Tiwari
1970 *Talchirella flavata* (Kar) Bharadwaj & Tiwari

Emended Diagnosis - Megaspores trilete, \pm circular in proximo-distal orientation, tri-radiate ridges straight, about 3/4 spore radius long, ending up near arcuate ridges, latter distinctly marked; exosporium granulate; mesosporium thin, transparent, smooth, spherical, proximal side showing a number of irregularly arranged cushions along tri-radiate mark.

Holotype - Slide no. 2219, Birbal Sahni Institute of Palaeobotany, Lucknow; *Kulti Formation*, Katri Nala Section near Dhanbad, Jharia Coalfield, Bihar.

Remarks - Bharadwaj and Tiwari (1970) instituted two species of *Talchirella*, viz., *T. vulgata* and *T. notabilis* with exactly the same characteristics except for the fact that the exosporium is rugose and smooth in the former and the latter has dense blunt papillae. The specimens figured by Dijkstra (1955, pl. 1, figs 3, 18) have been designated as the holotypes of the two species which is not appropriate since the inner bodies of the specimens described by Dijkstra (1955) are not known. Bharadwaj and Tiwari (1970) have not figured their own specimens on which to rely for ornamentation. The specimens described presently have granulate sculpture on the exosporium, and the inner body has irregularly arranged cushions. Hence, they have been placed under *Talchirella flavata*, the inner body of which has been described by Bharadwaj and Tiwari (1970) as having cushions arranged in multiserial fashion to form a loose triangle. However, on observing the type slide (Kar, 1968, pl. 1, fig. 1) no definite pattern of cushions is visible. Therefore, it can only be presumed that they are arranged irregularly along tri-radiate mark. The inner bodies of the specimens described here are torn and attached on one side.

Distribution - *Karharbari "Formation"* - Birsinghpur-Pali Coalfield (present study); *Kulti Formation* - Jharia Coalfield (Kar, 1968)



Map 5

Genus - *Banksisporites* Dettmann 1961 emend. Banerji, Kumaran & Maheshwari 1978

Type species - *Banksisporites pinguis* (Harris) Dettmann 1961

Remarks - The genus *Banksisporites* was instituted by Dettmann (1961) for Lower Mesozoic trilete, cavate megaspores consisting of homogenous or granulate nexine (mesosporium), smooth to granulate sexine (exosporium) and straight to sinuous tri-radiate ridges. Bharadwaj and Tiwari (1970) instituted a new genus *Srivastavaesporites* for almost similar type of megaspores with an additional diagnostic feature, viz., presence of well-defined contact areas; a feature not mentioned by Dettmann (1961) in diagnosis of the genus *Banksisporites*, although one of the figured specimens does clearly show well-developed arcuate ridges (Dettmann, 1961, pl. 1, fig. 14), a fact also mentioned by Banerji, Kumaran and Maheshwari (1978, p.

4). Incidentally, though Bharadwaj and Tiwari (1970) have emphasized on the presence of distinct contact areas, two of the species described by them, viz., *Srivastavaesporites dijksrae* (Bharadwaj & Tiwari, 1970, pl. 2, figs 13-15) and *S. tenuis* (Pant & Srivastava, 1962, pl. 18, fig. 34) do not show well-defined contact areas.

Banksisporites utkalensis Pant & Srivastava 1961
comb. nov.

Pl. 2, fig. 7; Pl. 6, fig. 17

1961 *Triletes utkalensis* Pant & Srivastava
1970 *Srivastavaesporites karanpurensis* Bharadwaj & Tiwari
1970 *Srivastavaesporites utkalensis* Bharadwaj & Tiwari
1975 *Srivastavaesporites panchetensis* Maheshwari & Banerji
1979 *Srivastavaesporites triassicus* Pant & Basu
1979 *Srivastavaesporites major* Pant & Basu
1983 *Srivastavaesporites singrauliensis* Pant & Mishra
1986 *Srivastavaesporites crassus* Pant & Mishra

PLATE 1

1,2. *Bokarosporites rotundus* (Singh) Bharadwaj & Tiwari; 1. Exosporium of megaspore in wet condition, Johilla Coalfield, BSIP slide no. 10461, x 100; 2. Neotype in wet condition showing smooth, inner body, Jharia Coalfield, BSIP slide no. 2236, x 100.

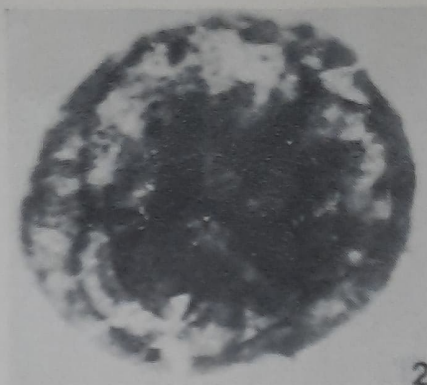
4, 6-7, 9, 10. *Talchirella trivedii* (Pant & Srivastava) Bharadwaj & Tiwari; 4. Mesosporium of megaspore in fig. 9 enlarged to show trigonally arranged cushions, BSIP slide no. 10466, x 200; 6. A megaspore in dry condition showing verrucate exosporium, Mohpani Coalfield, x 100; 7. Mesosporium of megaspore in fig. 6 in wet condition, showing a number of cushions arranged trigonally around tri-radiate mark, BSIP slide no. 10465, x 100; 9. A megaspore in wet condition, showing verrucate

exosporium and circular mesosporium with a number of cushions, Johilla Coalfield, BSIP slide no. 10466, x 200; 10. Mesosporium of a megaspore in wet condition, showing cushions, Mohpani Coalfield, BSIP slide no. 10468, x 100.

5,8,11. *Talchirella nitens* (Dijkstra) Bharadwaj & Tiwari; 5. Mesosporium of a megaspore in wet condition, showing a single row of cushions around tri-radiate mark, Mohpani Coalfield, BSIP slide no. 10463, x 100; 8. Proximal surface of a megaspore in dry condition, Mohpani Coalfield, x 100; 11. Megaspore in fig. 8 in wet condition showing a folded mesosporium, BSIP slide no. 10462, x 100.



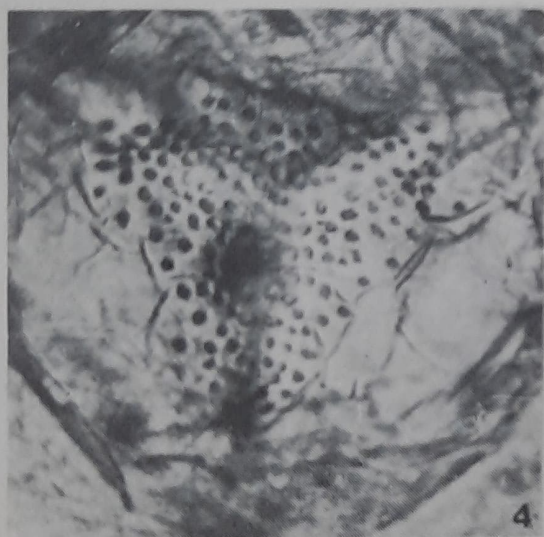
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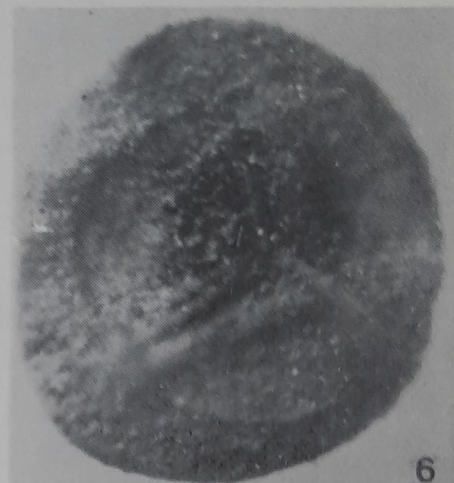
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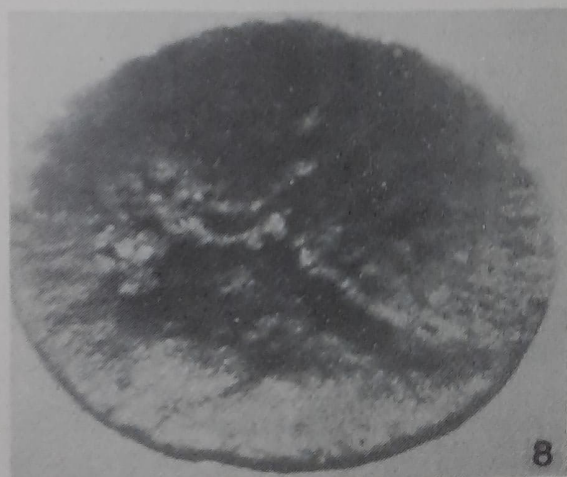
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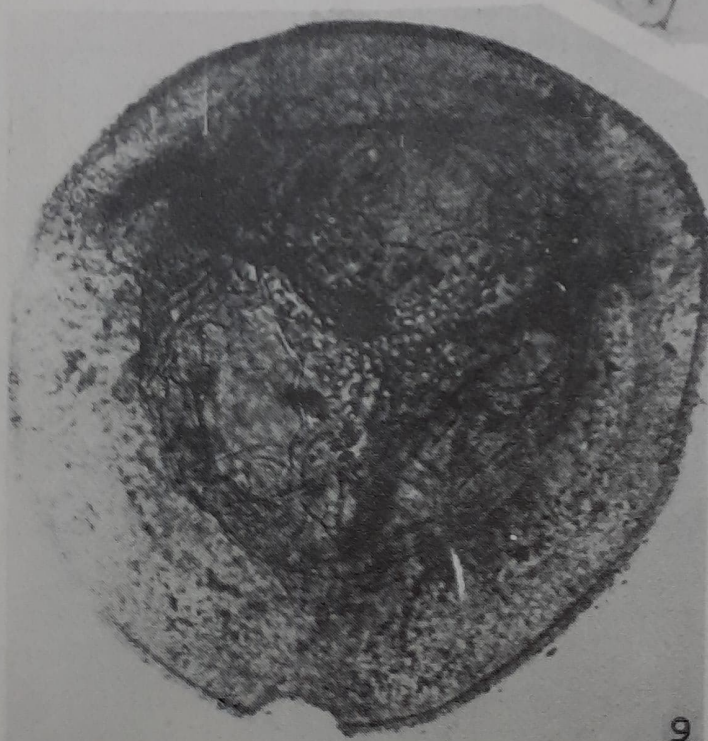
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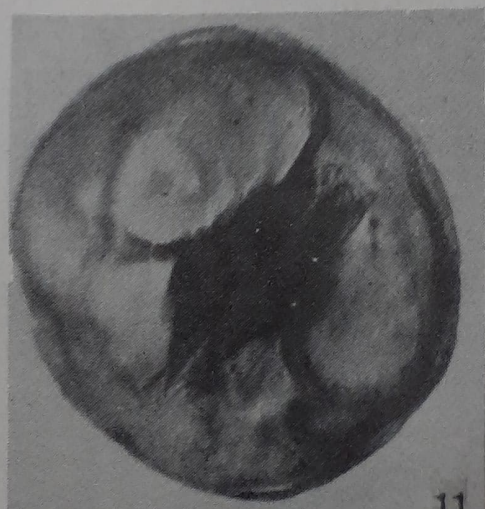
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11

Emended Diagnosis - Megaspores trilete, azonate, circular in proximo-distal orientation; tri-radiate ridges straight to wavy, more than 3/4 spore radius long, sometimes almost as long as radius, tapering towards ends, where bounded by distinct arcuate ridges; contact area wide, well-defined; exosporium granulate, grana uniformly disposed, usually 6-13 μm long and 6-13 μm wide at base; mesosporium distinct, spherical, transparent, smooth, big, almost as large as spore radius, devoid of cushions.

Holotype - Pant & Srivastava, 1961, pl. 31, fig. 19, slide no. 180, Divya Darshan Pant Collection, Department of Botany, Allahabad University, Allahabad, Lower Permian, Barakar Formation, Talcher Coalfield, Orissa.

Dimensions :

Overall size. 403-546 μm x 384-494 μm (dry condition), 499-749 μm x 480-650 μm (wet condition), 340-350 μm x 400-475 μm (after mounting in canada balsam).

Length of tri-radiate ridges. 134-210 μm (dry condition), 288 μm (wet condition), 188 μm (after mounting in canada balsam).

Width of tri-radiate ridges. 19-26 μm (dry condition), 38 μm (wet condition), 12 μm (after mounting in canada balsam).

Width of arcuate ridges. 19-26 μm (dry condition), 38 μm (wet condition), 4 μm (after mounting in canada balsam).

Size of grana. 6-13 μm x 6-13 μm (dry condition), 6 x 6 μm (wet condition).

Size of inner body. 520 μm (wet condition), 324-500 μm (after mounting in canada balsam).

The following three more species of the genus *Banksisporites* are identifiable in the Permian Gondwana of India.

Banksisporites endosporitiferus (Singh 1953) comb. nov.

1953 *Triletes endosporitiferus* Singh

1956 *Trileites* (al. *Triletes*) *endosporitiferus* (Singh in Sur., Singh & Sriv. 1953, S. 12, Taf. 2, fig. 6). Potonie

1970 *Srivastavaesporites endosporitiferus* (Singh) Bharadwaj & Tiwari

Banksisporites dijkstrae (Singh 1953) comb. nov.

1953 *Triletes dijkstrae* Singh

1953 *Triletes pseudopinguis* Srivastava

1953 *Triletes gymnozomatus* Schopf : Srivastava

1953 *Triletes translucens* Schopf : Srivastava

1953 *Sporites* sp. Srivastava

1953 *Triletes granulatus* Trivedi

1956 *Trileites* (al. *Triletes*) *dijkstrae* (Singh in Sur., Singh & Sriv. 1953, S. 12, Taf. 1, fig. 2) Potonie

1956 *Trileites* (al. *Triletes*) *pseudopinguis* (Srivastava in Sur., Singh & Sriv. 1953, S. 14, Taf. 3, fig. 11) Potonie

1970 *Srivastavaesporites dijkstrae* (Singh) Bharadwaj & Tiwari

Banksisporites linearis (Pant & Mishra 1986) comb. nov.

1986 *Srivastavaesporites linearis* Pant & Mishra

Two more species of megaspores, viz., *Triletes tenuis* and *T. labiosus* (Dijkstra, 1955, pl. 1, fig. 8 and pl. 2, fig. 31, respectively; *Srivastavaesporites tenuis* and *S. labiosus* of Bharadwaj & Tiwari, 1970) from the Gondwana of Brazil are also possibly referable to the genus *Banksisporites*.

Distribution - Karharbari "Formation" - Hutar, Johilla and Mohpani coalfields (present study); Barakar Formation- Chirimiri Coalfield (Bharadwaj & Tiwari, 1970); Raniganj Coalfield (Lele & Srivastava, 1983), South Karanpura Coalfield (Bharadwaj & Tiwari, 1970), Talcher Coalfield (Bharadwaj & Tiwari, 1970), Ib-river Coalfield (Bharadwaj & Tiwari, 1970), Singrauli Coalfield (Pant & Mishra, 1986), Korba Coalfield (Bharadwaj & Tiwari); Pali Formation- Nidhpuri, South Rewa (Pant & Basu, 1979); Maitur Formation- North-West branch of Nonia Nala, East of Kumarpur and North-West of Asansol (Maheshwari & Banerji, 1975).

Banksisporites indicus (Singh 1953) comb. nov.
Pl. 3, figs 1,9

1953 *Triletes indica* Singh

1961 *Talchirella endonigra* Pant & Srivastava

1970 *Srivastavaesporites indicus* (Singh) Bharadwaj & Tiwari

1974 *Srivastavaesporites indicus* (Singh) Bharadwaj & Tiwari : Lele & Chandra

1983 *Talchirella nigra* Lele & Srivastava

Emended Diagnosis- Megaspores trilete, azonate, circular in outline in proximo-distal orientation; tri-radiate ridges straight to wavy, uniformly wide throughout, 3/4 spore

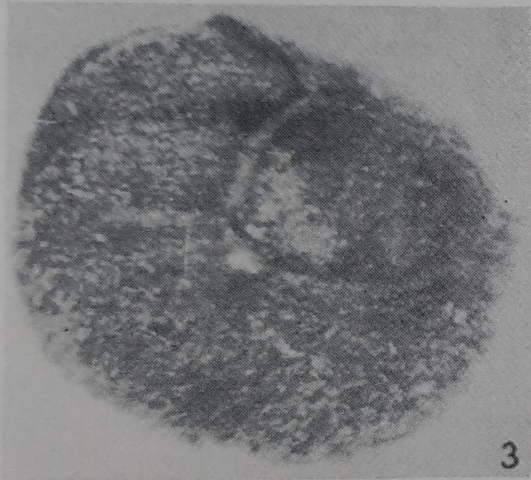
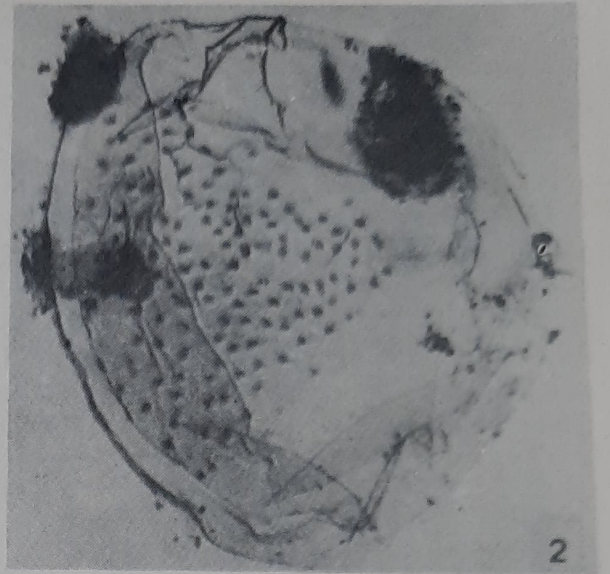
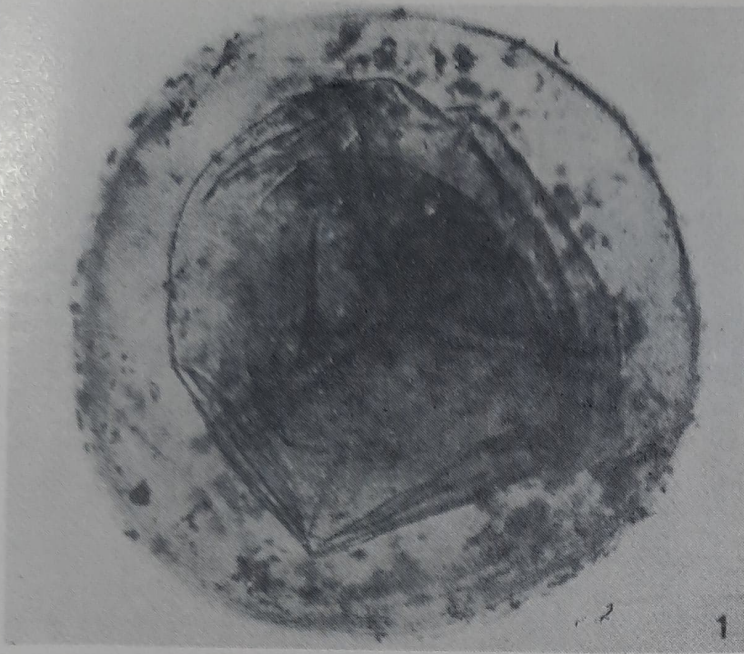
PLATE 2

1, 2. *Talchirella trivedii* (Pant & Srivastava) Bharadwaj & Tiwari; 1. A megaspore in wet condition, showing pitted mesosporium, Johilla Coalfield, BSIP slide no. 10464, x 200; 2. Mesosporium of a megaspore in wet condition, showing trigonally arranged cushions, Hutar Coalfield, BSIP slide no. 10467, x 100.
3-5 *Talchirella flavata* (Kar) Bharadwaj & Tiwari; 3. A megaspore in dry condition, Johilla Coalfield, x 100; 4. Another megaspore in dry condition, Johilla Coalfield, x 100; 5. Megaspore in fig. 3, in wet condition, showing

mesosporium with cushions (mesosporium split into two parts due to tearing), BSIP slide no. 10470, x 100.

6. *Banksisporites* sp. A triangular megaspore in wet condition, showing smooth triangular inner body (mesosporium), Johilla Coalfield, BSIP slide no. 10473, x 200.

7. *Banksisporites utkalensis* (Pant & Srivastava) comb. nov.; A megaspore in wet condition, showing exosporium and smooth, circular mesosporium, Johilla Coalfield, BSIP slide no. 10471, x 100.



radius long, ending up near arcuate ridges, latter distinctly marked; exosporium granulate; mesosporium spherical to subspherical, thin, filled with dark brown contents, devoid of cushions.

Neotype- The holotype not being traceable, a neotype is assigned here. Pl. 3, figs. 1,9, slide no. 10472 Birbal Sahni Institute of Palaeobotany, Lucknow; "Karharbari" (basal Barakar) Formation, Johilla Coalfield, Madhya Pradesh.

Remarks- Only one megaspore which can be assigned to *Banksisporites indicus* (Singh) comb. nov. was isolated from the present collection. During treatment with alkali the exosporium dissolved, leaving behind the inner body. Hence, no measurements of the size of the megaspore, its tri-radiate and arcuate ridges could be taken in wet condition.

Talchirella nigra (Lele & Srivastava, 1983, pl. 2, fig. 19; text-fig. 1D) has been merged here with *B. indicus* (Singh) comb. nov., since no cushions were found while studying the type slide (B.S.I.P. no. 6453).

Distribution - *Talchir Formation* - Johilla Coalfield (Lele & Chandra, 1974), *Karharbari "Formation"* - Hutar and Johilla coalfields (present study); *Barakar Formation* - Raniganj Coalfield (Lele & Srivastava, 1983), Bokaro Coalfield (Singh 1953; Bharadwaj & Tiwari, 1970), Talcher Coalfield (Pant & Srivastava, 1961; Bharadwaj & Tiwari, 1970), Ib-river Coalfield (Bharadwaj & Tiwari, 1970).

Banksisporites sp.
Pl. 2, fig. 6

Description- Trilete megaspore, triangular in outline in proximo-distal view. Tri-radiate ridges 3/4 spore radius long, straight, uniformly broad throughout, ending up near arcuate ridges, latter indistinct, contact area not well-defined, exosporium granulate. Differential maceration in HNO₃ and KOH reveals thick, dark brown, small, about less than 1/2 spore radius, triangular mesosporium devoid of cushions.

Dimensions :

Overall size. 384 µm (dry condition), 365 µm x 558 µm (wet condition), 375 µm (after mounting in canada balsam). *Thickness of exine*. 20 µm (after mounting in canada balsam).

Length of tri-radiate ridges. 115 µm (dry condition), 288 µm (wet condition), 120-176 µm after mounting in canada balsam).

Width of tri-radiate ridges. 19 µm (dry condition), 29 µm (wet condition), 24 µm (after mounting in canada balsam).

Width of arcuate ridges. 230 µm x 250 µm (dry condition), 244 µm x 208 µm (after mounting in canada balsam).

Remarks - *Banksisporites* sp. differs from all the other known species of the genus in having triangular shape and triangular dark brown inner body.

Genus- *Duosporites* Høeg, Bose & Manum 1955 emend. Bharadwaj & Tiwari 1970

Type species - *Duosporites congoensis* Høeg, Bose & Manum 1955

Remarks - The genus was instituted by Høeg, Bose and Manum (1955) for the "tri-radiate megaspores with smooth or nearly smooth surface" with inner body, the proximal surface of which is provided with cushions. However, the surface of megaspores is not smooth as mentioned by the authors but rather granulate (pl. 2, fig. 2), a character, also observed by Pant and Srivastava (1962). Bharadwaj and Tiwari (1970) have expanded the diagnosis to include verrucae along with grana, as the ornamentation of exine.

Duosporites congoensis Høeg, Bose & Manum 1955
Pl.3, figs 4-5, 7

1955 *Duosporites congoensis* Høeg, Bose & Manum

Remarks- About fifty megaspores were studied and it was observed, that as soon as KOH was added the exosporium dissolved rapidly no matter how little amount of KOH was used, leaving behind the spherical inner body with cushions. This may be due to poor preservation. Therefore, no photograph of macerated megaspore with exine intact could be taken. All the measurements of wet spores, excluding the inner body, are in water, before the KOH was added.

Distribution - *Talchir Formation*- Johilla Coalfield (Lele & Chandra, 1974); *Karharbari "Formation"*- Hutar Coalfield (present study); *Barakar Formation* - West Bokaro Coalfield (Bharadwaj & Tiwari, 1970); *Kulti Formation* - Jharia Coalfield (Kar, 1968); *Lower*

PLATE 3

1,9. *Banksisporites indicus* (Singh) comb. nov.; 1. Proximal view of a megaspore in dry condition, Johilla Coalfield, x 100; 9. Mesosporium of megaspore in fig. 1, in wet condition, showing dark (brown) inner contents, BSIP slide no. 10472, x 100.
2,8,10-11. *Barakarella pantii* Lele & Srivastava; 2. Proximal view of a megaspore, in dry condition, Johilla Coalfield, x 100; 8. Mesosporium of a megaspore, in wet condition, showing a number of cushions arranged trigonally around triradiate mark, Mohpani Coalfield, BSIP slide no. 10479, x 100; 10. Megaspore in fig. 2 mounted in canada balsam, BSIP slide no. 10477, x 100; 11. Megaspore in fig. 2, in wet condition, showing baculate exosporium and pitted, circular mesosporium with a number of

cushions arranged trigonally around tri-radiate mark, BSIP slide no. 10477, x 100.

3, 6. *Duosporites neerjiaie* sp. nov.; 3. Proximal view of the holotype in dry condition, Mohpani Coalfield, x 100; 6. Mesosporium of megaspore in fig. 3, in wet condition, showing a thick wall and a number of cushions, BSIP slide no. 10476, x 100.

4,5,7. *Duosporites congoensis* Høeg, Bose & Manum; 4. Mesosporium of a megaspore, in wet condition, showing a single row of cushions, Hutar Coalfield, BSIP slide no. 10474 x 100; 5. Mesosporium in fig. 4, mounted in canada balsam, BSIP slide no. 10474, x 100; 7. Mesosporium of a megaspore, in wet condition, showing a single row of cushions, Hutar Coalfield, BSIP slide no. 10475 x 100.

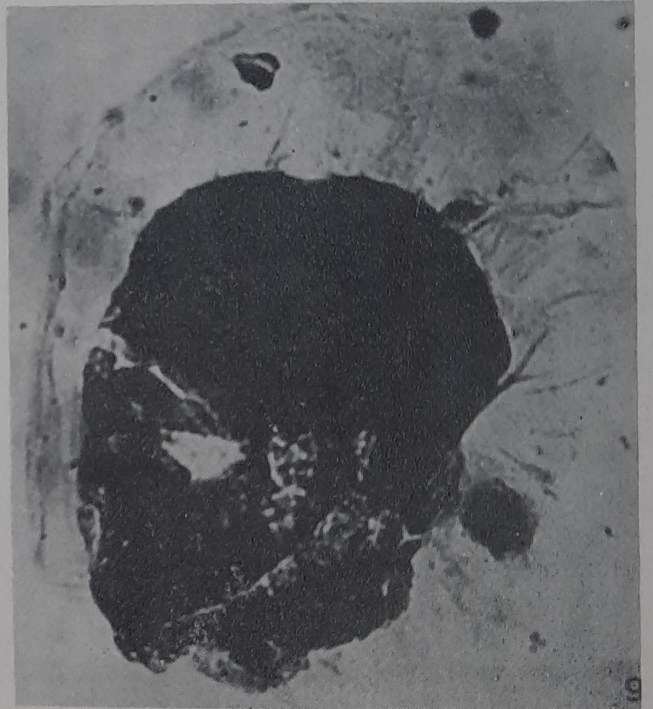
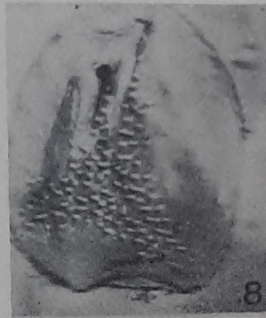
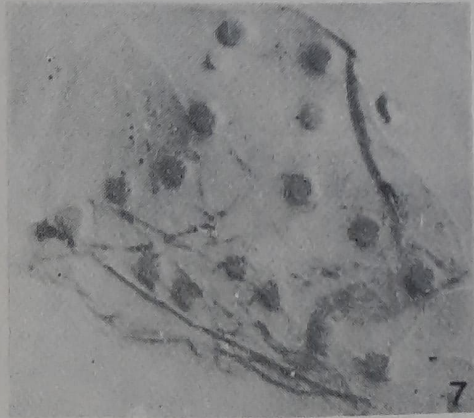
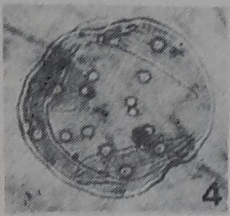
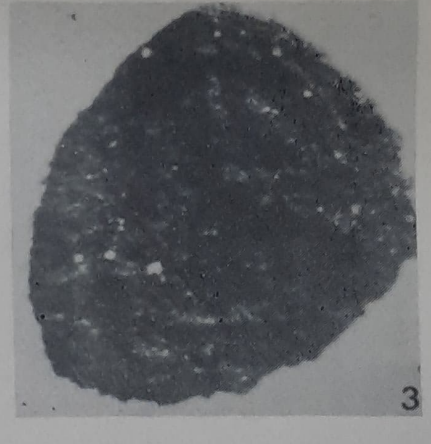
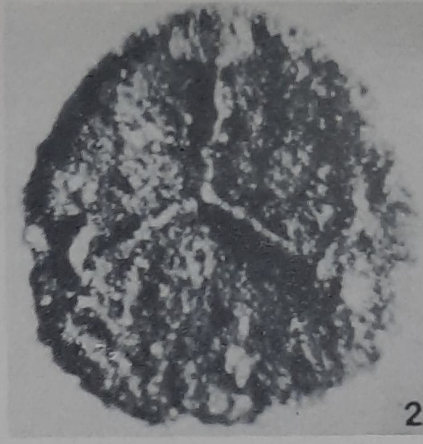
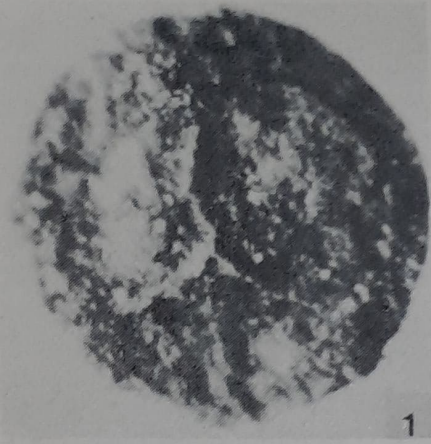


PLATE 3

Gondwana, Luena, Kisulu Coll., Vand de Steen, Zaire (Høeg, Bose & Manum, 1955).

Duosporites neerjiaae sp. nov.

Pl.3, figs 3,6

Diagnosis - Trilete megaspores, azonate, triangular in outline in proximo-distal view; tri-radiate ridges up to more than 3/4 spore radius long, apparently reaching beyond the contact area; latter distinctly marked; exosporium verrucate; mesosporium transparent, triangular, thick-walled, with a number of irregularly arranged cushions along tri-radite mark.

Holotype - Slide no. 10476, Birbal Sahni Institute of Palaeobotany, Lucknow; "Karharbari"/Basal Barakar Formation, Mohpani Coalfield, Madhya Pradesh.

Derivation of name - After Dr Ms Neerja Jha, Birbal Sahni Institute of Palaeobotany, Lucknow.

Description - Megaspore distinctly triangular. Tri-radiate mark with straight ridges, two of which end at contact area, one slightly extends beyond it, an incipient stage of reaching beyond contact area, contact area prominent, contact ridges not very well-developed; exosporium with ill-developed verrucae. Exosporium completely dissolving by differential maceration, revealing transparent, apparently triangular, thick-walled mesosporium, probably infolded at margins; cushions distributed unevenly in three different areas along the faintly visible trilete mark.

Dimensions :

Overall size. 468 x 442 μ m (dry condition)

Length of tri-radiate ridges. 384 μ m (dry condition)

Width of tri-radiate ridges. 39 μ m (dry condition)

Width of arcuate ridges. 26 μ m (dry condition)

Size of verrucae. 7-13 μ m x 3-7 μ m (dry condition)

Size of inner body. 312 μ m x 384 μ m (wet condition); 384 μ m x 244 μ m (after mounting in canada balsam)

Size of cushions 13 μ m x 13 μ m (wet condition); 8 μ m (after mounting in canada balsam)

Comparison - The species differs from all the earlier described species in one or more respects. In *Duosporites multipunctatus* (*D. inequalis* Pant & Mishra, 1986, text-fig. 8E) the tri-radiate ridges distinctly extend beyond the contact area (Bharadwaj & Tiwari, 1970, pl. 13, figs 1-3, 5; text-figs 27-29) and the inner body is thin-walled (*loc. cit.*, pl. 13, fig. 4; text-figs 29, 31). The inner body, however, resembles in having numerous cushions arranged in a triangular fashion around the tri-radiate mark.

D. irregularis has few, irregularly arranged cushions on

the mesosporium and the tri-radiate ridges reach beyond contact area. *D. dijksrae* also differs in nature and pattern of extension of tri-radiate ridges. The difference further lies in the arrangement of cushions, since they are biserially arranged around the tri-radiate mark. *D. katrinalaensis* differs in showing scabrate exosporium (in dry condition) and few irregularly arranged cushions on the inner body. It is proposed here to merge *D. umrensis* (Agashe, 1980, pl. 2, figs 8-11; text-figs 1,2) with *D. katrinalaensis* since no rugulae or coni are visible (on the exosporium) in the figures and rest of the characters are similar to *D. katrinalaensis*. In *D. inequalis* two of the tri-radiate ridges end at contact area and the third extends beyond it. This seems to be due to preservation. No half tone illustrations have been given by the authors. On the basis of similarity of rest of the characters, including those of inner body, *D. inequalis* is being merged here with *D. multipunctatus*.

Genus- Barakarella Lele & Srivastava 1983

Type species- Barakarella churuliaensis Lele & Srivastava 1983

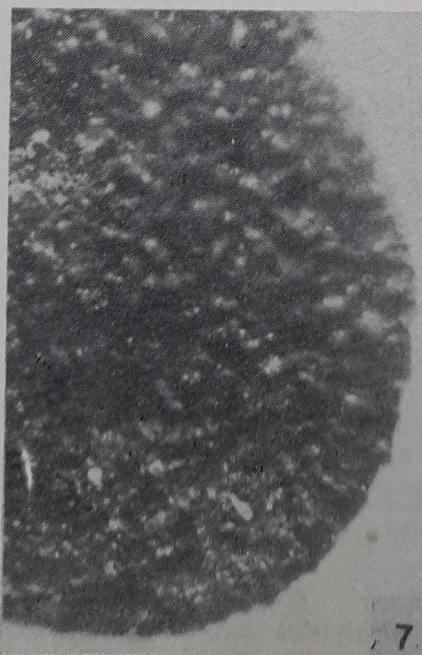
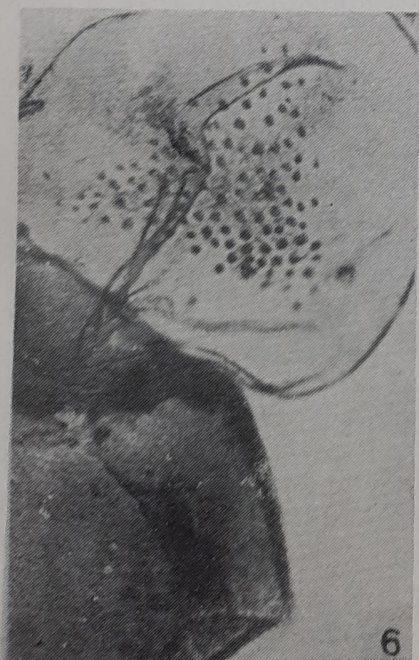
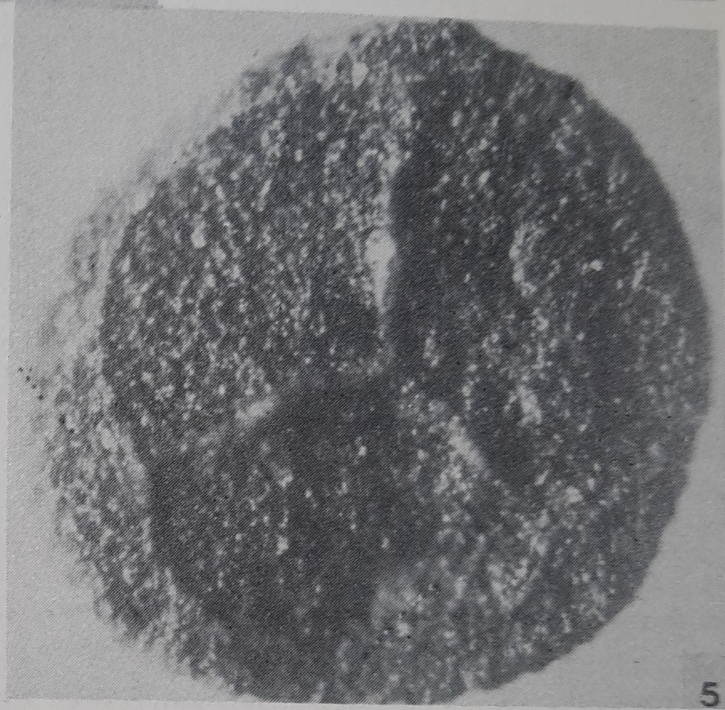
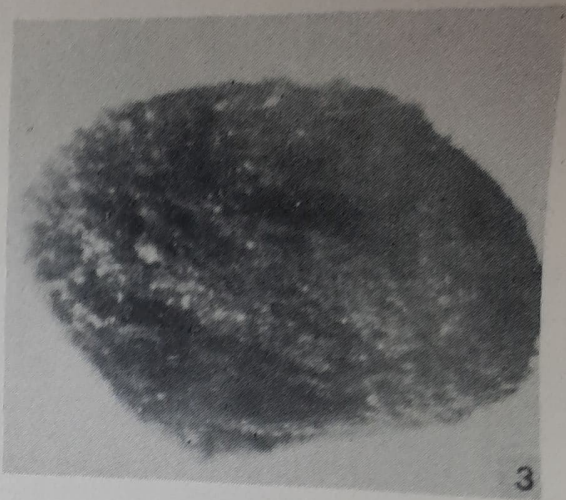
Remarks- Lele and Srivastava (1983) described two species of the genus *Barakarella*, viz., *B. churuliaensis* and *B. pantii* which, externally, appear to be similar except that cushions are comparatively fewer in former (10-15). Lele and Srivastava (1983) have also mentioned that tri-radiate ridges are prominent in *B. churuliaensis* and indistinct in *B. pantii* although the photographs of the dry megaspores of both the species (Lele & Srivastava, 1983, pl. 11, fig. 20; pl. 12, fig. 25) do not show well-defined tri-radiate ridges. They become distinct after chemical processing as observed in type slides. Arcuate ridges are clear neither in dry nor in wet condition.

The bacula are reported to be longer and more closely placed in *B. churuliaensis* than in *B. pantii*. On reexamination of the type specimens of both the species it was found that they are similar. Pant and Mishra (1986) reported a species *Rewatriletes minor* (for genus *Rewatriletes* see remarks on genus *Jhariatriletes*) having baculate exosporium and obscure cushions on the mesosporium (inner body). Some specimens of *R. minor* (Pant & Mishra, 1986, pl. 3, figs 20-23; text-fig. 7A-F) show verrucae mixed with bacula. Presence of obscure cushions is the diagnostic feature of *Barakarella churuliaensis*. Hence *R. minor* is being merged here with *Barakarella churuliaensis*.

PLATE 4

1,2. *Barakarella pantii* Lele & Srivastava; 1. Mesosporium of a megaspore in wet condition, showing trigonally arranged cushions, Giridih Coalfield, BSIP slide no. 10478, x 100; 2. Mesosporium of a megaspore in wet condition, Hutar Coalfield, BSIP slide no. 10480, x 100.
3,4. *Barakarella prakashii* sp. nov.; 3. Proximal view of holotype in dry condition showing connate exosporium, Mohpani Coalfield, x 100; 4. Holotype in wet condition, showing circular mesosporium with a single

row of cushions around tri-radiate mark. BSIP slide no. 10481, x 100.
5-8. *Barakarella shuklae* sp. nov.; 5. Proximal view of holotype in dry condition, Hutar Coalfield, x 100; 6. A megaspore in wet condition, showing mesosporium with trigonally arranged cushions, Johilla Coalfield, BSIP slide no. 10483, x 100; 7. Distal view of holotype in dry condition, x 100. 8. A megaspore in wet condition, Johilla Coalfield, BSIP slide no. 10484, x 200.



Barakarella churuliaensis Lele & Srivastava 1983

1983 *Barakarella churuliaensis* Lele & Srivastava
1986 *Rewatriletes minor* Pant & Mishra

Barakarella pantii Lele & Srivastava 1983 emend.
Pl. 3, figs 2, 8, 10-11; Pl. 4, figs 1, 2

1983 *Barakarella pantii* Lele & Srivastava

Emended Diagnosis - Megaspores trilete, subcircular to circular in proximo-distal view; tri-radiate ridges straight to sinuous, uniformly broad throughout, ending up near arcuate ridges, latter indistinct to well-defined; exosporium baculate, bacula thin, slender, uniformly distributed, more distinct at margins, mesosporium thin, globular, smooth, hyaline with a number of cushions arranged trigonally along tri-radiate mark.

Distribution - Karharbari "Formation" - Johilla, Mohpani, Giridih and Hutar coalfields (present study); Barakar Formation- Raniganj Coalfield (Lele & Srivastava, 1983).

Barakarella prakashii sp. nov.
Pl. 4, figs 3, 4

Diagnosis - Megaspores trilete, more or less circular in proximo-distal orientation; tri-radiate ridges sinuous, 3/4 of spore radius long, ending up near arcuate ridges, latter indistinct in dry condition; exosporium baculate; mesosporium subspherical, thin, smooth, hyaline, with one row of cushions arranged along tri-radiate mark.

Holotype - Slide no. 10481, Birbal Sahni Institute of Palaeobotany, Lucknow; "Karharbari"/ basal Barakar Formation, Mohpani Coalfield, Madhya Pradesh.

Derivation of name - After Dr Anand Prakash who collected this material.

Dimensions :

Overall size. 390-624 µm x 312-624 µm (dry condition), 900µm x 718 µm (wet condition), 500µm x 425 µm (after mounting in canada balsam).

Thickness of exine. 20 µm (after mounting in canada balsam).

Length of tri-radiate ridges. 208-312 µm (dry condition), 208 µm (wet condition), 384 µm (after mounting in canada balsam).

Width of tri-radiate ridges. 26 µm (dry condition), 19 µm

(wet condition), 36 µm (after mounting in canada balsam).
Width of arcuate ridges. 26 µm (dry condition), 52 µm (wet condition) 20 µm (after mounting in canada balsam).
Size of baculae. 6.5-13 µm x 6.5-13 µm (dry condition), dissolved (wet condition).

Size of inner body. 572 x 494 µm (wet condition), 425 x 350 µm (after mounting in canada balsam).

Size of cushions. 26 µ x 26 µm (wet condition), 16 µm x 16 µm (after mounting in canada balsam).

Comparison - *Barakarella churuliaensis* differs in having few cushions scattered in trigonal zone along trilete mark. *B. pantii* differs in having numerous cushions.

Note. Bacula are not observable in wet condition because they dissolve during maceration.

Barakarella shuklae sp. nov.
Pl. 4, figs 5-8; Pl. 5, fig. 1

Diagnosis - Trilete megaspores, circular, subcircular, subtriangular in outline in proximo-distal orientation; tri-radiate ridges 3/4 of spore radius long, ± straight, uniformly broad throughout, ending up near arcuate ridges, latter distinctly marked; contact area well-defined; exosporium conate, coni small with blunt apices; mesosporium thin, hyaline, spherical with a number of cushions arranged trigonally along tri-radiate mark.

Holotype - Slide no. 10482, Birbal Sahni Institute of Palaeobotany, Lucknow; "Karharbari"/basal Barakar Formation, Hutar Coalfield, Bihar.

Derivation of name- After Dr Manoj Shukla who collected this material.

Dimensions :

Overall size. 346-770 µm x 365-676 µm (dry condition), 403-1186 µm x 365-1134 µm (wet condition), 375-1125 µm x 375-1075 µm (after mounting in canada balsam).

Thickness of exine. 12-28 µm (after mounting in canada balsam).

Length of tri-radiate ridges. 134-312 µm (dry condition), 130-390 µm (wet condition), 140-475 µm (after mounting in canada balsam).

Width of tri-radiate ridges. 19-26 µm (dry condition, 6.5-39 µm (wet condition), 20 µm (after mounting in canada balsam).

Length of coni. 12-26 µm (dry condition, 6-26 µm (wet condition), 12 µm (after mounting in canada balsam).

PLATE 5

1. *Barakarella shuklae* sp. nov. Holotype in wet condition, showing connate exosporium and pitted mesosporium with a number of cushions arranged trigonally around the triradiate mark, BSIP slide no. 10482, x 100.
2, 4, 5. *Jhariariletes filiformis* sp. nov. 2. Proximal view of a part of megaspore in wet condition. Johilla Coalfield, BSIP slide no. 10487, x 200; 4. Proximal view of holotype in dry condition, Johilla Coalfield, x

100; 5. Holotype in wet condition, showing filiform appendages on exosporium and folded, smooth mesosporium, BSIP slide no. 10486, x 3, 6. *Biharisporites spinosus* (Singh) Potonie emend.; 3. Proximal view of a megaspore in dry condition, Mohpani Coalfield, x 100; 6. A megaspore in wet condition showing spinate exosporium and smooth mesosporium, Johilla Coalfield, BSIP slide no. 10487A, x 100.

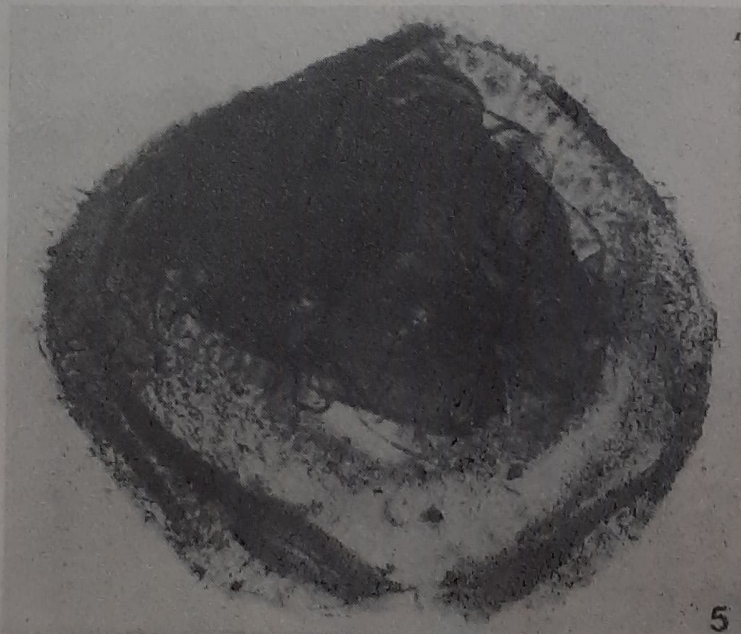
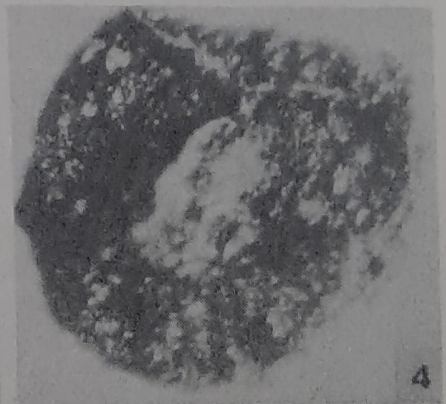
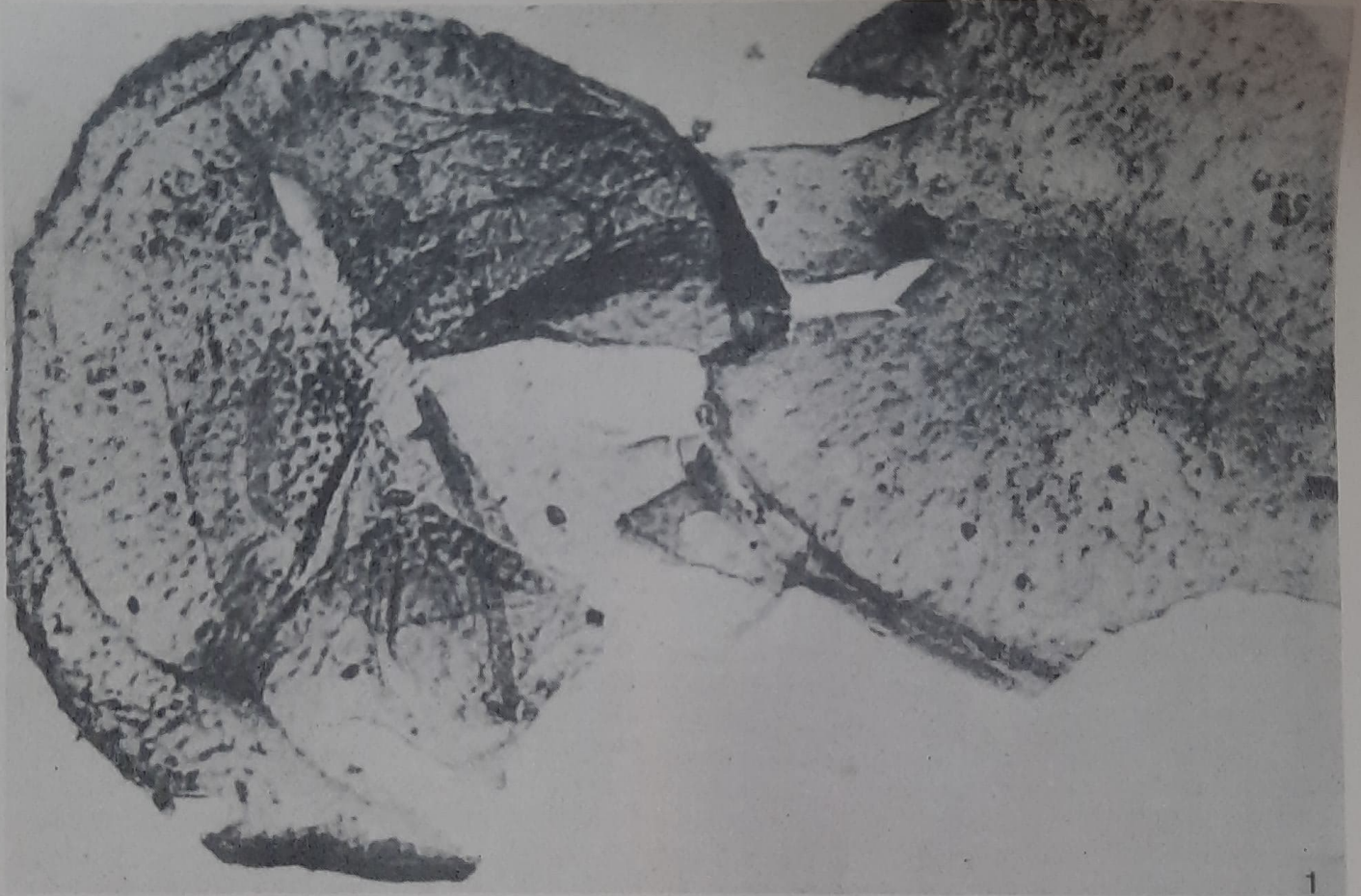


PLATE 5

Width of coni at apex. 3-6.5 μm (dry condition), 3-13 μm (wet condition), 2 μm (after mounting in canada balsam).

Width of coni at base. 6-26 μm (dry condition), 3-20 μm (wet condition), 4 μm (after mounting in canada balsam).

Size of inner body. 192-1030 μm x 192-848 μm (wet condition), 280-750 μm x 336-750 μm (after mounting in canada balsam).

Size of cushions. 13-26 μm (wet condition), 4-12 μm (after mounting in canada balsam).

Comparison- *Barakarella shuklae* differs from all the known species of the genus in having conate appendages. During maceration coni of the holotype dissolved but they are visible in other specimens.

Genus-*Biharisporites* Potonie emend. Bharadwaj & Tiwari 1970
1986 *Bulbosia* Pant & Mishra

Type species - *Biharisporites (Triletes) spinosus* (Singh) Potonie' 1956

Remarks- Pant and Mishra (1986) instituted the genus *Bulbosia* for circular to sub-circular megaspores which have exosporium covered with apiculi (coni) with bulbous bases and sharp, pointed tips, indistinct contact areas without contact ridges and unpitted mesosporium with dark contents. This genus is distinguished from *Biharisporites* by the presence of indistinct contact areas, absence of contact ridges and presence of mesosporium with dark contents. According to the authors the genus *Bulbosia* was recognised only after being mounted. It is quite possible that contact ridges disappeared during maceration. Moreover, presence or absence of contact ridges is a preservational factor. The only difference which remains then is the presence of dark contents in the mesosporium of *Bulbosia*. Mesosporium in *Biharisporites* is membranous. However, since no photographs of the genus *Bulbosia* have been given by Pant and Mishra, the nature of mesosporium remains doubtful.

Biharisporites spinosus (Singh 1953) Potonie' emend.
Pl.5, figs 3,6

1953 *Triletes spinosus* Singh
1953 *Triletes myrmecodes* Harris : Srivastava
1953 *Triletes mangardahensis* Srivastava
1953 *Triletes gondwanensis* Srivastava
1953 *Triletes datmensis* Srivastava
1953 *Triletes kotahensis* Trivedi
1953 *Triletes singraulensis* Trivedi

1953 *Triletes savitrii* Srivastava
1956 *Biharisporites* (al. *Triletes*) *myrmecodes* (Harris, 1935, S. 160, Taf. 26, fig 4) Potonie
1956 *Biharisporites* (al. *Triletes*) *datmensis* (Srivastava in Sur., Singh & Sriv., 1953, S. 15, Taf. 4, fig. 18), Potonie'
1956 *Biharisporites* (al. *Triletes*) *spinosus* (Singh in Sur., Singh & Sriv., 1953, S. 12, Taf. 1, fig. 1) Potonie'
1970 *Biharisporites spinosus* (Singh) Pot. 1956 emend. Bharadwaj & Tiwari
1986 *Biharisporites robustus* Pant & Mishra
1986 *Bulbosia rewaensis* Pant & Mishra

Emended Diagnosis - Trilete megaspores, circular in outline in proximo-distal view; tri-radiate ridges 3/4 spore radius long, straight to sinuous, ending up near arcuate ridges, latter indistinct to well-defined; exosporium spinate, spines closely placed, more prominent at margins; mesosporium thin, spherical, hyaline, more than 1/2 spore radius in diameter, devoid of cushions.

Description - Megaspores are usually circular in outline but sometimes may be subcircular or subtriangular. Tri-radiate ridges are prominent, straight to wavy, usually uniformly wide, sometimes tapering. Arcuate ridges are usually well-defined, but sometimes may be indistinct. Exosporium is spinate, spines are generally small, well-defined, closely placed, usually with blunt apices. They can be seen more distinctly at margins than elsewhere. Differential maceration in HNO_3 and KOH reveals well-defined spherical inner body devoid of cushions.

Remarks - Bharadwaj and Tiwari (1970) diagnose the species as having "spines and setae compactly and \pm uniformly placed all over the body." Setae, however, could not be observed in the specimens of present collection nor in the photographs given by Bharadwaj and Tiwari (1970, pl. 8, figs 14-19; pl. 9, figs 1-5). Since the slides of the specimens described by Bharadwaj and Tiwari (1970) are not available, presence of setae could not be confirmed.

Distribution - *Karharbari "Formation"* - Johilla Coalfield (Present study); *Barakar Formation* - Bokaro Coalfield (Singh, 1953; Srivastava, 1953), South Karanpura, Sohagpur, Korba and Ib-river coalfields (Bharadwaj & Tiwari, 1970), Singrauli Coalfield (Trivedi, 1953; Pant & Mishra, 1986); *Kulti Formation* - Jharia Coalfield (Bharadwaj & Tiwari, 1970); *Raniganj Formation* - Raniganj Coalfield (Bharadwaj & Tiwari, 1970).

Genus - *Jhariatriteles* Bharadwaj & Tiwari 1970 emend.
Pant & Mishra 1986

PLATE 6

1, 7. *Banksisporites ukalensis* (Pant & Srivastava) comb. nov.; 1. Scanning electron micrograph of proximal view of a megaspore in dry condition. Mohpani Coalfield, x 150; 7. Scanning electron micrograph of a megaspore in dry condition, Hutar Coalfield, x 150.

2,3,5,8. *Talchirella trivedii* (Pant & Srivastava) Bharadwaj & Tiwari; 2. Scanning electron micrograph of a portion of megaspore in fig. 3 showing ornamentation, x 400; 3. Scanning electron micrograph of a megaspore showing verrucate exosporium and a well defined tri-radiate mark,

Mohpani Coalfield, x 150; 5. Scanning electron micrograph of another portion of megaspore in fig. 3 showing ornamentation, x 500; 8. Scanning electron micrograph of proximal view of another megaspore, Giridih Coalfield, x 150.

4,6. *Bokarosporites rotundus* (Singh) Bharadwaj & Tiwari; 4. Scanning electron micrograph of a megaspore in dry condition, Hutar Coalfield, x 150; 6. Scanning electron micrograph of another megaspore in dry condition, showing laevigate exosporium, Hutar Coalfield, x 150.

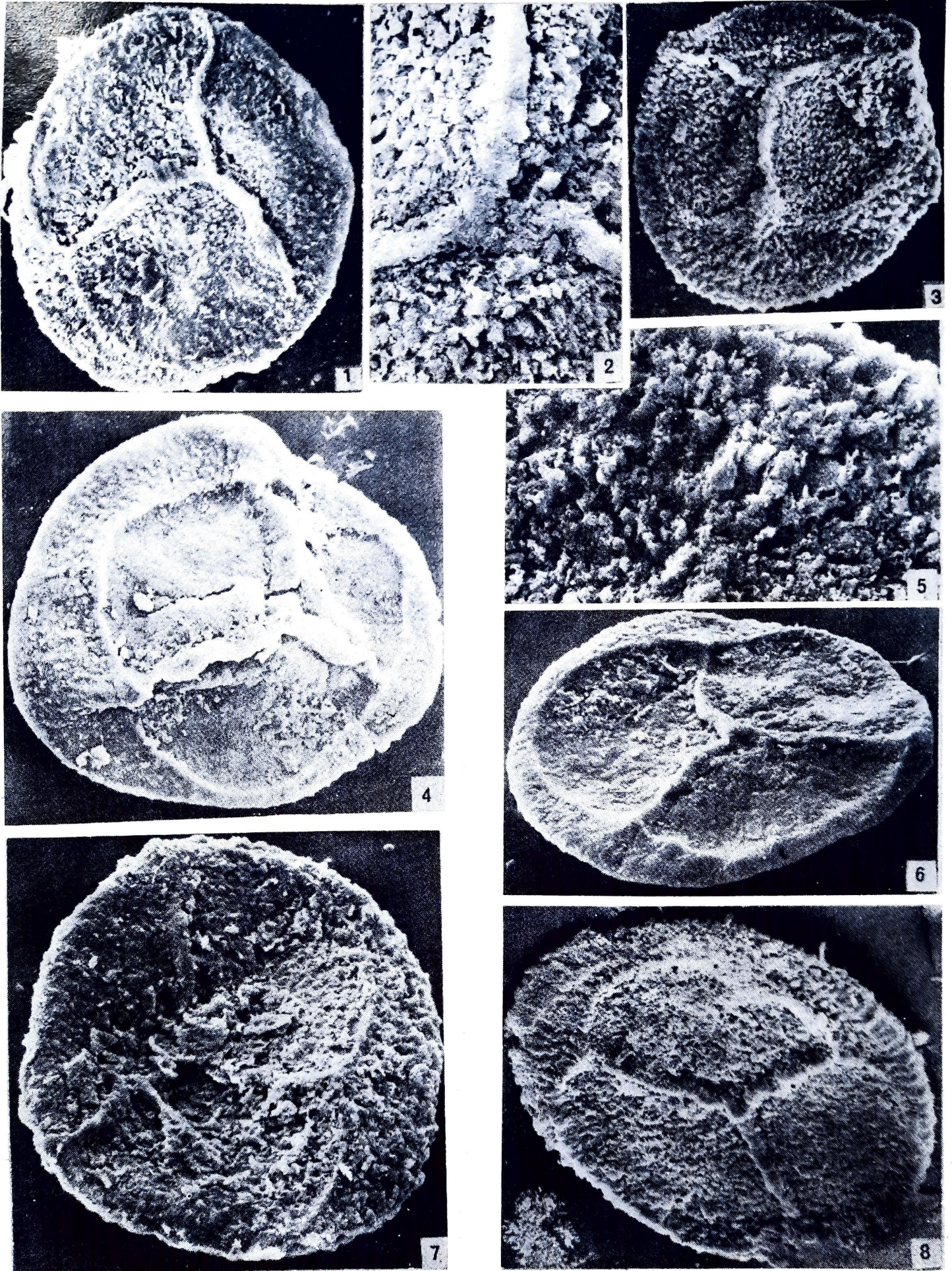


PLATE 6

1986 *Verrubacutriteles* Pant & Mishra

Type species - *Jhariatriteles baculosus* Bharadwaj & Tiwari 1970

Remarks - Though according to original diagnosis the mesosporium (inner body) in these megaspores is usually thin, hyaline, more or less circular and without cushions, yet Lele and Srivastava (1983, pl. 3, figs. 28-30; text-fig. 11) have reported a thick, dark brown inner body in *Jhariatriteles densus*. Pant and Mishra (1986) reported mixed verrucate and baculate ornamentation on the exosporium in *J. baculosus*. Pant and Mishra (1986) instituted a new genus, viz., *Verrubacutriteles* for two species of *Jhariatriteles* (*J. srivastava*, C. Bharadwaj & Tiwari, 1970, pl. 8, figs 1-10 and *J. distinctus*) which differ from type species *J. baculosus* in having indistinct contact area. Indistinct contact area is considered to be a preservational factor and hence the genus *Verrubacutriteles* is superfluous. Bharadwaj and Tiwari (1970, p. 35) also mention that "In some species the differential distribution of ornamental processes demarcates the line of contact area where the contact rim is indistinct."

Pant and Mishra (1986) erected another genus *Rewatriteles* on the basis of exclusively baculate exosporium and pitted or unpitted mesosporium. This genus is not recognized here since, presence or absence of cushions in a mesosporium is regarded as characteristic diagnostic feature, i.e., a megaspore genus can only have either pitted or unpitted mesosporium, never both. Moreover, figures of *Rewatriteles* show mixed verrucate and baculate ornamentation as also found in *Jhariatriteles* and *Barakarella* and not solely, baculate appendages as mentioned by the authors. The only difference in the two genera, viz., *Jhariatriteles* and *Barakarella* is the absence of cushions in the mesosporium of former and their presence in the latter. Therefore, those species of *Rewatriteles* which have cushions in the inner body are included here under the genus *Barakarella* (see remarks on the genus *Barakarella*) and those which lack cushions are placed under the genus *Jhariatriteles*.

Jhariatriteles binaensis (Pant & Mishra 1986) comb. nov.

1986 *Rewatriteles binaensis* Pant & Mishra, *Palaeontographica* B198 : 35, pl. 4, figs 27-30; text-fig. 6A-E.

1986 *Rewatriteles comatus* Pant & Mishra, *Palaeontographica*, B198 : 37, pl. 4, figs 24,26; text-fig. 6A-E.

1986 *Rewatriteles sidhiensis* Pant & Mishra, *Palaeontographica*, B198 : 37, pl. 2, figs 13, 14; text-fig. 8A-D.

Remarks - *Rewatriteles sidhiensis* has been merged with *Jhariatriteles comatus* because the two species show identical characters except for the difference in the length of baculae, which are much longer (up to 65 μm) in *R. sidhiensis* and covered with a hyaline sheath. The difference in length of baculae has not been regarded here as a feature of diagnostic importance. As for presence of a

covering of a hyaline sheath over baculae of *J. sidhiensis*, the photographs do not show this character (Pant & Mishra, 1986, pl. 2, figs 13,14).

Jhariatriteles filiformis sp. nov.

Pl. 5, figs 2, 4-5

Diagnosis - Trilete megaspores, subcircular to circular in proximo-distal orientation; tri-radiate ridges sinuous, uniformly broad throughout, 3/4 spore radius long, ending up near faintly visible arcuate ridges; contact area indistinct; exosporium baculate, bacula long, slender, thin, sparsely distributed, more prominent at margins, verrucae visible in dry condition, mesosporium thin, spherical, hyaline, smooth, much folded, devoid of cushions.

Holotype-Slide no. 10486, Birbal Sahni Institute of Palaeobotany, Lucknow; "Karharbari"/basal Barakar Formation, beds exposed near the confluence of Ganjra Nala with Johilla River, Birsinghpur Pali, Shahdol District, Madhya Pradesh.

Dimensions :

Overall size. 461-557 μm x 384-499 μm (dry condition), 653-749 μm x 538-768 μm (wet condition); 370-650 μm x 325-500 μm (after mounting in canada balsam).

Thickness of exine. 8-12 μm (after mounting in canada balsam).

Length of tri-radiate ridges. 192-288 μm (dry condition), 288 μm (wet condition); 160 μm (after mounting in canada balsam).

Width of tri-radiate ridges. 19-38 μm (dry condition), 38 μm (wet condition); 20 μm (after mounting in canada balsam).

Width of arcuate ridges. 19 μm (dry condition); 19 μm (wet condition), 8 μm (after mounting in canada balsam).

Length of baculae. 9-13 μm (dry condition), 12-43 μm (wet condition).

Width of baculae. 3-12 μm (dry condition), 3-12 μm (wet condition), 2-8 μm (after mounting in canada balsam).

Size of inner body. 326-499 μm x 173-403 μm (wet condition), 300-475 μm x 300-325 μm (after mounting in canada balsam).

Comparison - During alkali treatment it was observed that tri-radiate ridges and arcuate ridges (latter not distinct) usually get dissolved. *J. srivastavae* differs in having densely and uniformly disposed larger baculae. *J. baculosus* has differentially distributed baculae which are sparse on contact area and closely set beyond it. *J. damudicus* differs in having bigger, sparsely distributed baculae. *J. densus* Lele & Srivastava is characterized by the presence of granulate, thick, dark brown inner body. *J. binaensis* differs in showing much longer and wider baculae (30-40 μm x 15-20 μm), their apices being slightly swollen or globular. Similarly, *J. comatus* differs in showing much larger baculae (up to 65 μm long and 20 μm wide).

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