A megaspore assemblage from the Athgarh Formation and its bearing on the age of the formation

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Megaspores have been recorded from the Athgarh Formation of Mahanadi Basin. The megaspore assemblage comprises species of *Banksisporites, Bacutriletes, Erlansonisporites, Minerisporites, Saccarisporites, Paxillitriletes*, and seed structures referable to *Spermatites*. The megaspore assemblage has a preponderance of the genera *Paxillitriletes* and *Minerisporites* in association with other Early Cretaceous forms, and thus supports the age arrived at on the basis of megafloral data. Spore/pollen investigations had earlier revealed an age ranging between Upper Jurassic to Lower Cretaceous.

Key-words—Megaspores, Athgarh Formation, Mahanadi Basin, Lower Cretaceous, India.

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सारांश

अथगढ़ शैल-समूह से एक गुरुबीजाणु समुच्चय तथा शैल-समूह की आयु से इसका सम्बन्ध

बृजेन्द्र नाथ जाना एवं अमित कुमार घोष

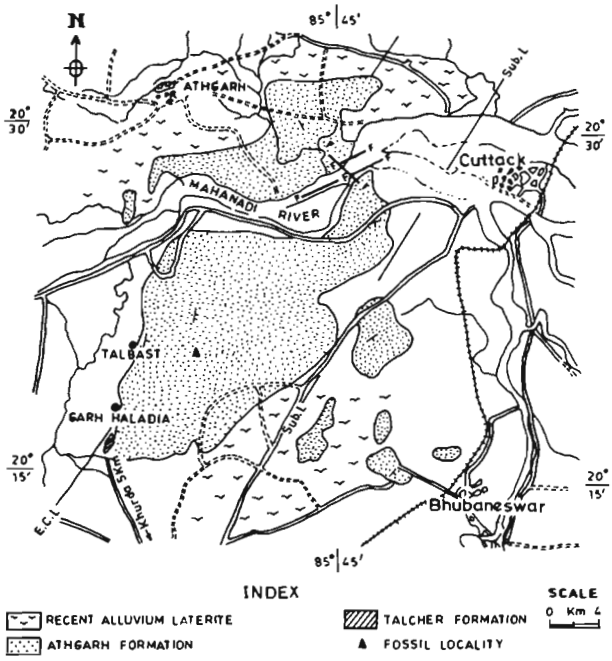
महानदी द्रोणी में अथगढ़ शैल-समूह से गुरुबीजाणु अभिलिखित किये गये हैं। इस गुरुबीजाणु समुच्चय में *बैंकसिस्पोराइटिस, बेक्युट्राइलिटीस, अर्लेन्सोनिस्पोराइटिस, माइनेरिस्पोराइटिस, सेक्केरिस्पोराइटिस, पैक्सीलीट्राइलिटीस* नामक प्रजातियों की जातियाँ तथा *स्पर्मेट्राइटिस* से तुलनीय बीज विद्यमान हैं जिनमें प्रारम्भिक क्रीटेश्यस प्ररूपों के साहचर्य में *पैक्सीलीट्राइलिटीस* एवं *माइनेरिस्पोराइटिस* की पूर्व बाहुल्यता है। इस प्रकार यह समुच्चय भी गुरुवनस्पतिजात के आधार पर आँकी गई आयु की पुष्टी करती है। बीजाणु-परागकण अन्वेषण से इस शैल-समूह की उपरि जूरेसिक से अधरि क्रीटेश्यस आयु आँकी गई है।

THE Athgarh Formation, often referred to as 'Athgarh Sandstone', constitutes a part of the Mesozoic sedimentary sequences in Mahanadi Basin. The Mesozoic sediments in Mahanadi Basin lie unconformably over the Precambrian rocks or at places rest unconformably over the Permian sediments. The Athgarh Formation comprises conglomerates, grits, sandstones with intercalations of lenticular white, pink, yellow, dark grey clays and shales, ferruginous and carbonaceous shales and fireclay (Ball, 1877; Adyalkar & Rao, 1963; Patra, 1980). It is, in turn, overlain by laterite and alluvium. The estimated thickness of the formation is about 400 meters (Kumar & Bhandari, 1973).

Ball (1877) first collected plant megafossils from the Athgarh Formation; Feistmantel (1877) described these fossils. Subsequently, Athgarh megaflora has been worked out in detail by several workers. The megafloral assemblage is dominated by pteridophytes and conifers followed by cycadophytes and Bennettitales. Ginkgoales and Caytoniales are rarely represented in the assemblage.

Maheshwari (1975) recorded an *Araucariactites*-rich palynoassemblage of Athgarh Formation from Sidheshwar Hill, Cuttack District and Jagannath Prasad Quarry, Puri District. Jana and Tiwari (1986) and Patra (1990) further made palynological investigations of the sediments exposed in the Sidheshwar Hill. Jana (1990) recovered a palynoassemblage dominated by the genus *Murospora* from the Athgarh Formation near Talbast.

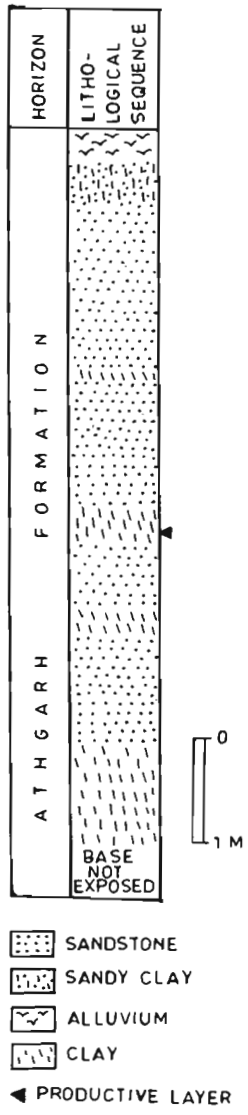
Samples for the present investigation on megaspores were collected from the exposure in an



Map 1—Geological map of a part of Athgarh Basin showing the fossil locality.

open cast 'Fire Clay Mine' in Talbast region. The mine is situated about 350 m east of Tata's Mine Guest House (Map 1). The section exposes alternate bands of sandstone and clay. Base of the section is not exposed and the top is covered by alluvium. The overall lithological sequence is represented in Text-figure 1. The megaspores were recovered from the 3rd clay band (from the base) which had earlier yielded miospores (Jana, 1990).

The megaspores were sorted out from the macerate which was collected over 150 sieve after treating the samples with hydrofluoric acid. The megaspores were dried and individual dry megaspore was studied and photographed under reflected light. The megaspore was then transferred to a



Text-figure 1—Lithological sequence of Tata's Fireclay Mine at Talbast region showing the sampling site.

covered petridish and oxidised in nitric acid. Sometimes, potassium chlorate was used to accelerate

PLATE 1

(All figures X 100, unless otherwise mentioned)

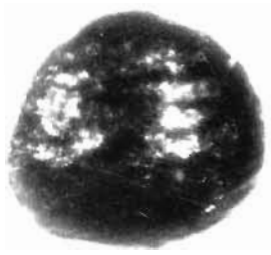
1, 2. *Banksisporites* sp. 1. Megaspore in dry state showing finely granulate exosporium; 2. Same megaspore after maceration showing disintegrated exosporium and dense mesosporium. Slide No. BSIP 11915.

3-5. *Erlansonisporites* sp. 3. Macerated megaspore in wet condition showing reticulate exosporium. Slide No. BSIP 11916; 4. Megaspore in dry state showing the reticulate ornamentation of exosporium; 5. Same megaspore in over-macerated condition. Slide No. BSIP 11917.

6. *Bacutriletes* sp. Megaspore in dry state showing well developed baculae on the proximal face. X 75; Slide No. BSIP 11918.

7-10. *Minerisporites auriculatus* Singh, Srivastava & Roy. 7. Megaspore in dry state showing distinct triradiate ridge and auriculi; 8. Same megaspore in wet condition after maceration; Slide No. BSIP 11919; 9. Another megaspore in dry state; 10. Same megaspore after overmaceration in wet condition. X 75. Slide No. BSIP 11920.

11, 12. *Minerisporites reticulatus* (Singh *et al.*) Banerji, Jana & Maheshwari; 11. A megaspore tetrad in dry state showing the proximal attachment of megaspores; 12. Same tetrad in wet condition showing a detached megaspore after maceration, remaining three are still proximally attached. X 75; Slide No. BSIP 11921.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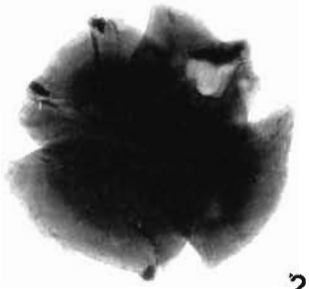
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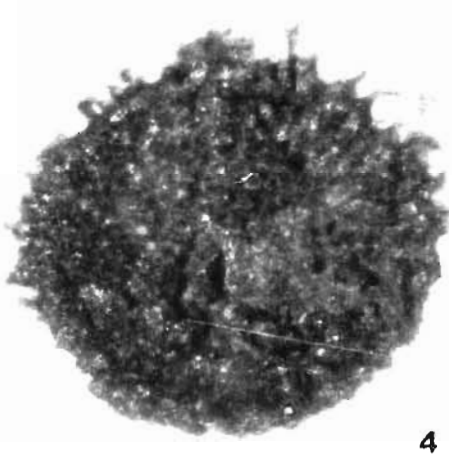
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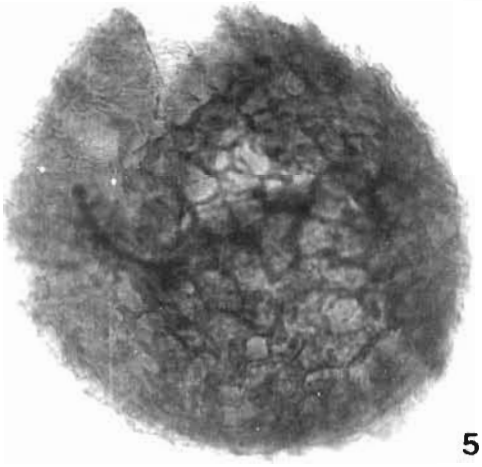
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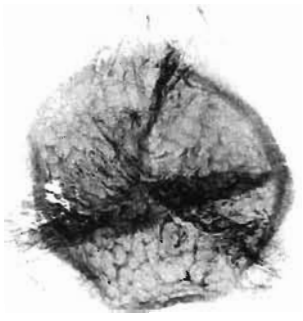
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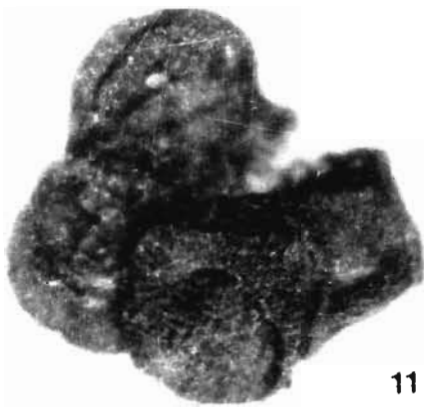
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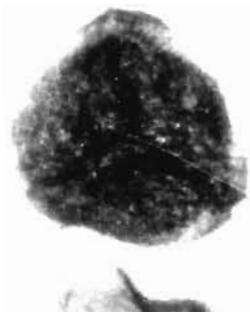
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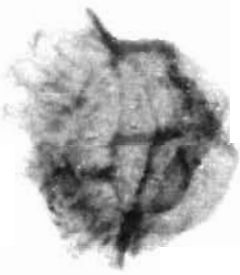

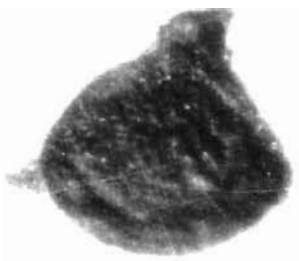
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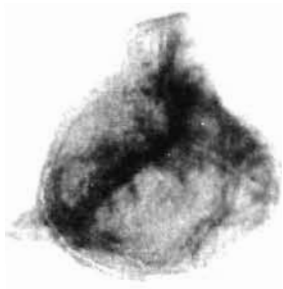
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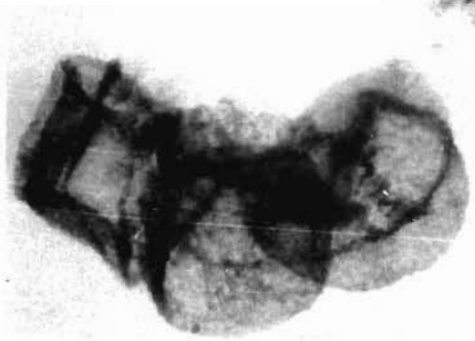
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PLATE 1

the oxidation process. After oxidation, the megaspores were digested, gradually, in dilute solution of potassium hydroxide and finally cleaned in water. During the gradual process of maceration photographs were taken in transmitted light. All the figured slides and negatives are preserved in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC DESCRIPTION

Anteturma — *Sporites* Potonié 1893
Turma — *Triletes* Reinsch emend. Potonié & Kremp 1954
Subturma — *Azonotriletes* Luber 1935
Infraturma — *Laevigati* Bennie & Kidston emend. Potonié 1956

Genus — Banksisporites Dettmann 1963 emend. Banerji, Kumaran & Maheshwari 1978

Banksisporites sp.
Pl. 1, figs 1-2

Description—Megaspores ± circular in outline, 310-325 µm in diameter in dry state and 350-385 µm in wet condition; triradiate mark and arcuate ridge not clearly discernible either in dry state or in wet condition; exosporium smooth to very finely granulate; mesosporium 320-350 µm in diameter.

Remarks—In overall appearance the specimens resemble those of *Banksisporites*, but in the absence of a distinct triradiate mark and arcuate ridge, these are not referable to any particular species of the genus.

Infraturma — *Apiculati* Bennie & Kidston 1854 emend Potonié 1956

Genus—*Bacutriletes* van der Hammen 1954 emend. Potonié 1956

Bacutriletes sp.
Pl. 1, fig. 6

Description—Megaspore ± circular, 510 X 550 µm in dry state and 580 X 640 µm in wet condition; triradiate mark not discernible in both dry state and wet condition; proximal face with well-developed, closely spaced, 6-13 µm long and 3-5 µm wide baculae; endosporium smooth, large and almost occupying the whole spore cavity.

Remarks—Due to restricted distribution pattern of baculae and absence of distinct triradiate mark the presently described specimen of *Bacutriletes* differs from those of known species, viz., *B. cutchensis* Singh *et al.*, *B. dijkstrae* Singh *et al.* and *B. srivastavae* Banerji *et al.* recorded from the Bhuj Formation of Kutch Basin.

Turma — *Zonales* (Bennie & Kidston 1886 ex Ibrahim) emend. Potonié 1956
Subturma — *Auritotriletes* Potonié & Kremp 1954
Infraturma — *Auriculati* Schopf ex Potonie & Kremp 1954

Genus — *Erlansonisporites* Potonié 1956

Erlansonisporites sp.
Pl. 1, figs 3-5

Description—Megaspores ± circular, 500-580 µm in dry state and 520-680 µm in wet condition, triradiate mark not clearly visible; exosporium ornamented with irregularly raised appendages, appendages anastomose to form reticula, meshes of reticula measuring 20 X 35 to 40 X 55 µm in wet condition.

Remarks—*Erlansonisporites* sp. apparently resembles *E. indicus* Banerji *et al.* from the Lower Cretaceous of Kutch Basin, but the former differs from the latter in having comparatively ill-developed appendages and indistinct triradiate mark.

PLATE 2 →

(All figures X 100, unless otherwise mentioned)

1. *Minerisporites reticulatus* (Singh *et al.*) Banerji, Jana & Maheshwari. Megaspore in overmacerated condition. X 75; Slide No. BSIP 11922.

2, 3. *Minerisporites auriculatus* Singh, Srivastava & Roy. 2. Megaspore in wet condition; Slide No. BSIP 11923; 3. Another megaspore in dry state showing well developed auriculi, Slide No. BSIP 11924.

4, 10. *Paxillitriletes maheshwarii* sp. nov. 4. Holotype in dry state; 5. Holotype after maceration showing reticulation on exosporium and webbed long branched and unbranched appendages; Slide No. BSIP 11925; 6. Another megaspore in wet condition after over-maceration; Slide No. BSIP 11926; 7. Same megaspore in dry state; 8. Megaspore in dry state; Slide No. BSIP 11927; 9. Another megaspore in dry state; 10. Same megaspore after maceration in wet condition; Slide No. BSIP 11928.

11, 12. *Saccarisporites* sp. 11. Megaspore in dry state. X 75; 12. Same magaspore after maceration. X 75; Slide No. BSIP 11929.

13, 14. *Spermatites* sp. 13. Specimen in dry state. X 75; 14. Same specimen after maceration in wet condition. X 75; Slide No. BSIP 11930.

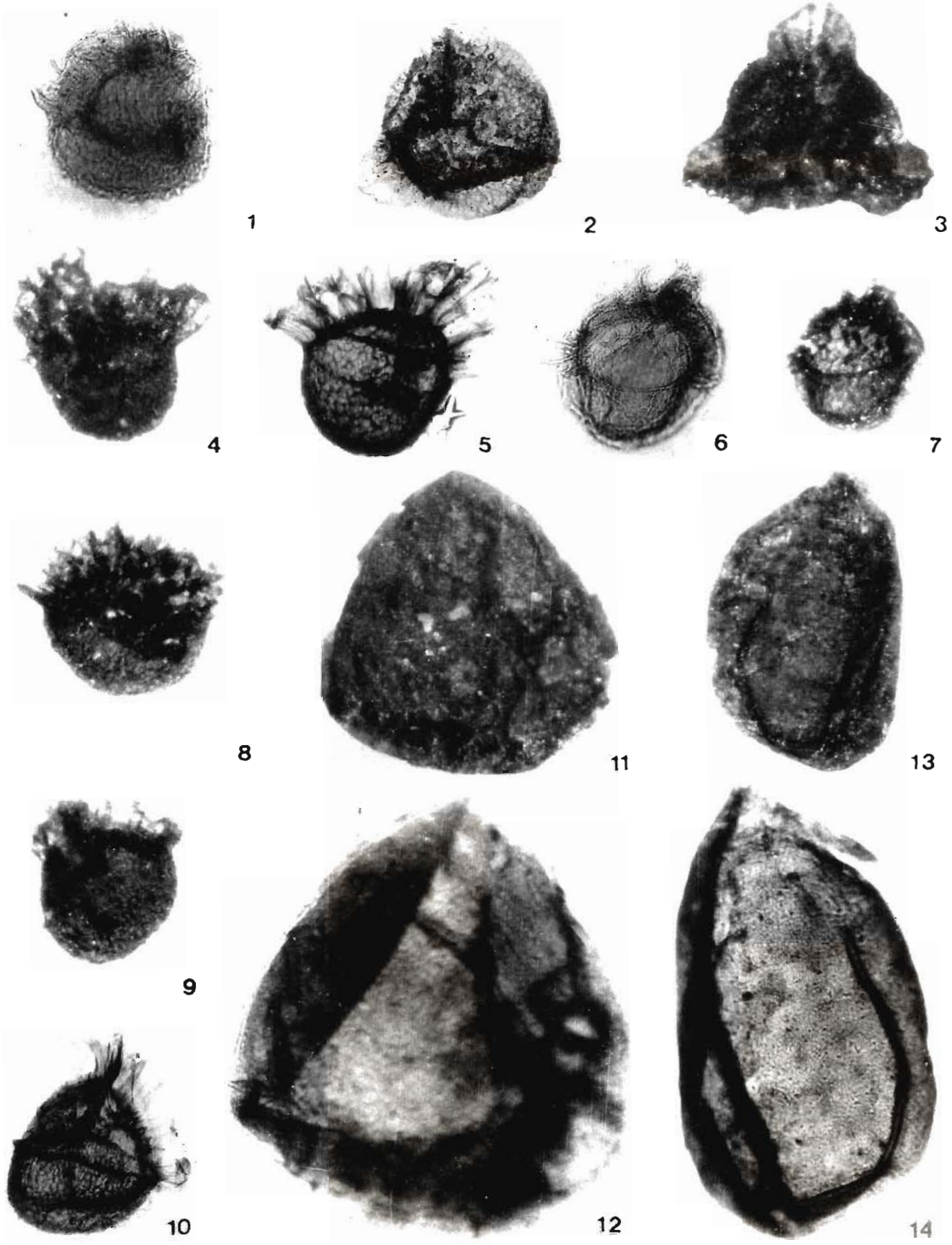

PLATE 2

Subturma — *Zonotriletes* Waltz 1935
Infraturma — *Zonati* Potonié & Kremp 1954

Genus — *Minerisporites* Potonié 1956

Minerisporites auriculatus Singh, Srivastava & Roy 1964
Pl. 1, figs 7-10; Pl. 2, figs 2-3

Remarks—In all available morphographic features and size, the specimens resemble those of *Minerisporites auriculatus* described by Singh, Srivastava and Roy (1964) from the Lower Cretaceous of Kutch Basin. The species is fairly rich in the present megaspore assemblage.

Minerisporites reticulatus (Singh, Srivastava & Roy 1964) Banerji, Jana & Maheshwari 1984
Pl. 1, figs 11-12; Pl. 2, fig. 1

Remarks–The present specimens found both in tetrad condition and dispersed condition resemble those of *Minerisporites reticulatus* recorded from the Lower Cretaceous of Kutch Basin.

Genus—*Paxillitriletes* Hall & Nicholson 1973

Paxillitriletes maheshwarti sp. nov.
Pl. 2, figs 4-10

Diagnosis–Megaspores trilete, amb ± circular in both equatorial and polar view, dimension 250-310 µm in dry state and 280-320 µm in wet condition; majority of the megaspores preserved laterally; trilete laesurae associated with a number of branched or unbranched appendages, appendages sometimes jointed at the base or throughout the whole length, measuring 50-150 µm in length in wet condition; exosporium reticulate, meshes of reticula measuring 10 X 14 µm to 15 X 20 µm, mesosporium not clearly discernible.

Comparison–Paxillitriletes battenti Banerji *et al.* is closely comparable to *P. maheshwarti* sp. nov. in overall shape and webbed nature of appendages, but the latter species is readily distinguishable in having spinose exosporium and comparatively larger size. *P. (Thomsonia) pseudotennella* (Dijkstra) Hall & Nicolson figured by Dijkstra (1951) differs from the present species in having conate exosporium.

Holotype–Pl. 2, figs 4 and 5, Slide No. BSIP 11925.

Type locality & age—Fireclay Quarry of Tata Refractories Ltd., Talbast, district Cuttack, Orissa; Athgarh Formation, Lower Cretaceous.

Derivation of name—The specific name is after Dr H. K. Maheshwari who has made significant contributions to the Indian Gondwana megaspores.

Genus—*Saccarisporites* Dev 1961

Saccarisporites sp.
Pl. 2, figs 11-12

Description—Megaspore subtriangular in outline, measuring 740 X 755 µm in dry state and 990 X 1020 µm in wet condition; exosporium very finely granulate with a few minor foldings.

Remarks—In overall shape and in exinal character the present specimen is comparable to *Saccarisporites* sp. recorded from the Jabalpur Formation by Dev (1961), but the present specimen is comparatively larger in size.

Incertae sedis

Genus—*Spermatites* Miner 1935

Spermatites sp.
Pl. 2, figs 13-14

Description—Elliptical to oval seed structure measuring 530 X 730 µm to 560 X 760 µm in dry state and 540 X 1020 µm to 580 X 1060 µm in wet condition, tapering on one end and broad at the other; surface finely granulose, sometimes with minor foldings but without any cellular structure.

Remarks—In overall appearance the seed structures are referable to *Spermatites*. In its shape the seed structures compare to some extent with *Spermatites indicus* Srivastava 1955 reported from the Barakar Formation of West Bokaro Coalfield. But no nucellar structure has been observed in the present specimens.

DISCUSSION

Among the known Late Mesozoic megaspore assemblages from Indian subcontinent, the Liassic assemblage from the Nammal Gorge, Pakistan (Sah & Jain, 1968) is characterised by the presence of *Bankisporites, Hughesisporites, Minerisporites* and *Nathortisporites*. The megaspore assemblage from Sehora-on-Sher, Madhya Pradesh (Dev, 1961) is represented by the genera *Minerisporites, Saccarisporites* and *Dijkstraisporites*. Banerji *et al.* (1984) recorded 27 species of megaspores belonging to 11 genera from the Lower Cretaceous of Kutch and

also reviewed the earlier work done by Singh *et al.* (1964). All the megaspore genera reported from the Sehora sediments of Madhya Pradesh (Dev, 1961) are also represented in the Kutch assemblage.

The present megaspore assemblage is closely comparable to that of Bhuj Formation (Kutch Basin) in having the presence of *Banksisporites, Bacutriletes, Erlansonisporites* and *Saccarisporites* along with the dominance of *Paxillitriletes* and *Minerisporites*. The Athgarh assemblage, however, is devoid of the genera *Hughesisporites, Verrutriletes, Horstisporites, Valvisisporites, Umiaspora* and *Dijkstraisporites*. The present megaspore assemblage may be assigned to the Assemblage Subzone B 2 of Maheshwari and Tewari (1988), though the genus *Dijkstraisporites* is not represented. The Athgarh megaspore assemblage shows the dominance of *Paxillitriletes* which is a very characteristic Lower Cretaceous form in The Netherlands, England and Canada (Dijkstra, 1949, 1951, 1959; Batten, 1969; Singh, 1964, 1971; Gunther & Hills, 1972).

Miofloral investigation on the Athgarh Formation was initiated by Maheshwari (1975). Jana and Tiwari (1986) reinvestigated the Athgarh palynoflora and assigned an Upper Jurassic age to it. But, the data on plant megafossils (Patra, 1980; Patra & Sahoo, 1995) indicate an Early Cretaceous age to the Athgarh Formation. The present megaspore assemblage conclusively points to a Lower Cretaceous age for the Athgarh Formation.

ACKNOWLEDGEMENTS

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