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NONIASPORITES, A NEW MEGASPORE GENUS FROM THE UPPER PERMIAN OF RANIGANJ COALFIELD

HARI K. MAHESHWARI & USHA BAJPAI
Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

ABSTRACT

The new type of megaspore recovered from a shale of Kumarpur Sandstone Member of the Raniganj Formation is characterized by the presence of a large number of rill-like exoexinal folds in the inter-ray areas. The rill-like folds mask the rays of the trilete mark. Another characteristic feature is the apparent absence of a mesosporium.

Key-words — Palynology, Megaspore, *Noniasporites*, Raniganj Formation, Upper Permian (India).

सारांश

रानीगंज कोयला-क्षेत्र के उपरि परमी कल्प से एक नवीन गुरुबीजाणु वंश : नोनियास्पोराइटिस – हरिकृष्ण माहेश्वरी एवं ऊषा बाजपेयी

रानीगंज शैल-समूह के कुमारपुर बालुकाश्म सदस्य की शैल से उपलब्ध यह नवीन प्रकार का गुरुबीजाणु मध्य-ग्ररीय क्षेत्र में धारा-सदृश बाह्यतम्चोल के घुमावों से ग्रभिलक्षणित हैं। ये धारा-सदृश घुमाव त्रिग्ररीय चिन्ह् के ग्ररों को ढके रहते हैं। बीजाणु-मध्यचोल की स्पष्ट ग्रनुपस्थिति इस गुरुबीजाणु के ग्रन्य विशिष्ट लक्षण की द्योतक है।

INTRODUCTION

AFTER the initial record of megaspores by Sitholey (1943), from the Salt Range Triassic, there have been occasional reports of megaspores from many other formations of the Indian Gondwana. These records have been summarized among others by Pant and Srivastava (1961), Bharadwaj and Tiwari (1970), Maheshwari and Banerji (1975) and Banerji, Kumaran and Maheshwari (1978). It has been observed that though certain megaspore taxa are long ranging in the stratigraphical sequence, yet there are few forms that are restricted to individual formations. Further, the megaspore types known so far, particularly the ones from the Lower Gondwana formations, have a mesosporium or inner body (Bharadwaj & Tiwari, 1970, p. 61) and its nature and organisation have usually been considered to be diagnostic features in megaspore taxonomy (Høeg, Bose & Manum, 1955; Bharadwaj & Tiwari, 1970; Lele & Chandra, 1974) or atleast relevant to the correct interpretation of megaspore morphology (Pettitt, 1966, p. 254).

While investigating megaspores from the Lower Gondwana formations of India, we found that one of the megaspore types from the Raniganj Formation did not reveal the presence of a mesosporium though a large number of specimens were subjected to differential maceration. To further confirm the absence of the mesosporium, ultra-thin sections were prepared and examined both under the light as well as the transmission electron microscopes. A mesosporium could not be deciphered by either method.

Being an interesting observation, we are reporting this particular type of megaspore in the present paper. However, we still do not rule out the presence of a mesosporium because of the possibility that these megaspores were preserved at an ontogenetic stage when the separation of nexine from the sexine had not yet started.

Bharadwaj and Tiwari (1970) recorded following megaspore taxa from the Toposi Kenda (VI) Seam of the Raniganj Formation: *Talchirella raniganjensis* Bharadwaj & Tiwari, 1970; *T. densicorpa* Bharadwaj & Tiwari, 1970; *Jhariatriletes baculosus* Bharadwaj & Tiwari, 1970; *Surangaesporites raniganjensis* Bharadwaj & Tiwari, 1970 and *Biharisporites spinosus* (Singh) Potonié, 1956. Our samples come from a shale sequence, slightly above the Upper Kajora (IX) Seam, exposed near the Burnpur Crossing-Technical College road bridge on the Nonia Nala near Asansol. The Lower Triassic Maitur Formation shales exposed in the same section have also yielded a variety of megaspores (Maheshwari & Banerji, 1975). The genera *Srivastavaesporites* (*Banksisporites*), *Biharisporites*, *Jhariatriletes* and *Talchirella* continue from the Raniganj Formation while the genera *Pantiella*, *Maiturisporites* and *Nathorstisporites* become introduced at this level.

METHOD

More than 300 megaspores of this type were recovered by dissolving the shale in hydrofluoric acid. After routine cleaning and washing in water, individual megaspores were dried at room temperature and studied in incident light. Selected specimens were then subjected to routine differential maceration (cf. Maheshwari & Banerji, 1975, p. 151) and rephotographed.

More than a dozen specimens of this type were micrographed on the scanning electron microscope for topographical features. For this purpose completely dry megaspores were stuck on a small piece of conductive silver tape which was placed on an Aluminium stub. The megaspores were coated with Gold and Palladium alloy in a Sputter Coater. The sample was then scanned in Cambridge Stereoscan 180 microscope. Micrographs were taken on an ORWO NP 22, 120 roll film.

The megaspores for transmission electron microscopy were prepared according to the technique given by Taylor and Rothwell (1982). After embedding in Spurr's low viscosity resin, ultrathin sections were cut with glass knives on LKB ultratome III. Sections (700-800 Å) were picked upon Formvar coated 400 mesh copper grids and stained with 1% aqueous uranyl acetate for 15 minutes (Watson, 1957). The sections were examined under Hitachi Electron Microscope (H.U.-11E) at an accelerating voltage of 75 KV and selected areas were photographed on Fuji Orthochromatic sheet film.

SYSTEMATIC DESCRIPTION

Anteturma — *Sporites* H. Potonié, 1893
Turma — *Barbates* Mädler, 1954

Genus — *Noniasporites* gen. nov.

Type Species — *Noniasporites harrisii* sp. nov.

Diagnosis — Megaspores acavate, apparently trilete, circular to sub-circular in shape. Triradiate ridges raised, wavy, usually indistinguishable from radially oriented, exoexinal, simple or branched, rill-like structures occurring on contact faces. Contact areas not clearly demarcated by curvaturae. Exine laevigate, homogenous in sections, comprising discrete sporo-pollenin units.

Description — The megaspores which have been assigned to this genus occur in all possible views ranging from proximo-distal to oblique to lateral. While in proximodistal view the megaspores are more or less circular, in lateral view the spore outline is broadly oval. Because of this the spores generally show an exinal fold near the equator. It has not been possible to clearly demonstrate, even under the scanning electron microscope, if the megaspores have a trilete mark. Most of the megaspores show a distorted, M- or W-shaped structure at the place where a tetrad mark is expected (Pl. 2, figs 8, 10). It is apparent that the tetrad mark is a trilete whose rays are thick and much raised. The trilete laesurae are often masked by a large number of rill-like exoexinal structures which occur in a radial orientation in the inter-ray areas. These rill-like structures are either simple or branched towards outside. Under the optical microscope the exine looks to be laevigate but under the scanning electron microscope (Pl. 2, figs 12, 13) it gives a corroded appearance. The acavate nature of the spore is clearly demonstrated in thin sections (Pl. 1, fig. 5). Ultrathin sections (Pl. 1, fig. 6) show that the exine is homogeneous and composed of discrete units of sporo-pollenin.

Comparison — The most characteristic features of the megaspores included here under the new genus *Noniasporites* is the exine ornamentation in the inter-ray areas. Mädler (1954, p. 147) established the Turma *Barbates* to include those spore taxa which had a strongly developed exine ornamentation in the inter-ray areas. This ornamentation could comprise, capilli, fimbriae, bacula, spinae, etc. Of the megaspore genera falling in the Turma *Barbates* the genus *Hughesisporites* Potonié, 1956 resembles somewhat the new genus. The genus *Hughesisporites*, which is so far known to range from Upper Triassic to Lower Cretaceous in age (Banerji, Kumaran & Maheshwari, 1978; Marcinkiewicz, 1962, 1976; Dettmann, 1961; Hughes, 1955; Dijkstra, 1951; Harris, 1935, etc.), is characterized by the presence of verrucae or spinae in the inter-ray areas (Potonié, 1956, p. 70). *Noniasporites*, however, is clearly distinguishable (i) in having rill-like features in the inter-ray areas, (ii) by triradiate laesurae marked by inter-ray ornamentation, and (iii) in the apparent absence of a mesosporium.

Noniasporites harrisii sp. nov.

Pl. 1, figs 1-6; Pl. 2, figs 8-13; Text-fig. 1

Holotype — Pl. 1, figs 1, 2; slide no. BSIP 6998 (megaspore mounted after differential maceration).

Type Locality — Nonia *nala* (stream), adjacent to Technical College Bridge near Asansol-Burnpur Crossing, Burdwan District, West Bengal.

Derivation of name — After the late Professor Thomas Maxwell Harris.

Diagnosis — As for the genus.

Description — Megaspores are circular to subcircular in outline and 275-337 μm in diameter. Even after differential maceration the megaspores generally retain the same outline though in water or KOH their size may show a marked increase (275-399 μm). The trilete mark which is not distinguishable in incident or transmitted light is, however, resolved under the scanning electron microscope due to its higher depth of focus and resolving power. The rays are much raised and highly wavy. The contact area is not well-marked but can be defined by the presence of a number (26-46) of fine rills. Under transmitted light as well in the SEM micrographs the rills appear to be simple or once branching away from the trijunction. These rills are probably formed as exoexinal extensions as is seen in thin sections of the megaspores (Pl. 1, fig. 5). The thin sections, as the partially macerated megaspores, show that the mesosporium is not present in this species. A transmission electron microscope study of the sporoderm layer indeed shows a homogeneous layer which is composed of discrete sporo-pollenin units. Usually the megaspores show a separation of nexine from sexine forming a mesosporium, both in fossil and living megaspores (cf. *Isoetes coromandelina* L.; Pl. 1, fig. 7). Due to poor preservation of the fossil megaspores the thickness of exine is not uniform all over. The SEM micrographs of both the proximal and the distal surfaces show a corroded topography.

TEXT-FIG. 1 — *Noniasporites harrisii* gen. et sp. nov. a free-hand sketch of the megaspore illustrated on plate 2, fig. 9.

CONCLUDING REMARKS

The megaspores so far known from the Gondwana of India all have two things in common, i.e. the presence of a distinct trilete tetrad mark and a mesosporium (inner body). *Noniasporites* is significant in that the presence of the trilete mark is not indubitably proved in the proximal-distal orientation of the megaspore. However, in oblique or lateral orientation, one can make out the tetrad mark which apparently is trilete with thick, much wavy and raised rays. As the inter-ray proximal area of the megaspores is studded with rill-like exinal modifications (? infolds) similar in extent to the tetrad rays, the latter are mostly masked. The mesosporium is also not seen, both in transmitted light or in thin sections. A similar situation regarding mesosporium has also been observed in *Tasmanitriletes* (*Triletes*) *pedinacron* (Harris, 1935) Jux & Kempf, 1971.

In most other megaspores, both extant and extinct, however, there is a clear indication of the separation of an inner layer of the sporoderm from an outer layer. Usually these two layers in megaspores were equated with nexine and sexine respectively. However, Kempf (1970, 1971a, 1971b, etc.) is of the opinion that the outer thick layer is a perine and the inner thin layer represents the exine. He further regards the separation of the 'exine' from the 'perine' to be either due to laboratory treatment or as an artefact of preservation and thus of no consequence as a taxonomic character. However, it is difficult to agree with Kempf's either conclusion at least with regards to fossil megaspores. The perine has always been regarded as an 'extra-exinous' wall layer deposited presumably by the activity of a periplasmodium (Bower, 1923) and as such could not be correctly identified without reference to ontogeny of the megaspore (Harris, 1955). Pokrovskaya *et al.* (1950) and Potonié and Kremp (1955, p. 17) have found that the perine is rather easily lost in fossil condition along natural separation surfaces. However, a perispore is not unknown in fossil megaspores (cf. Dijkstra, 1946, etc.) but it is not clear if the 'perispore' of Dijkstra is the same as the 'perine' of Jackson. In the extant species of the genera *Isoetes* and *Selaginella*, the 'perispore' is thick and silicified (Pettitt, 1966, pp. 227, 232). We have found that this layer often dissolves even in very dilute alkali, leaving two clear layers, an outer sexine and an inner nexine.

Similarly the constant occurrence of a mesosporium in almost all the fossil megaspores could not be a preservation artefact. Furthermore, mesosporia are almost universally present in megaspores of extant species, too. The occurrence of certain characteristic elements, e.g. 'cushions' on the mesosporium of the genus *Duosporites* is certainly not a preservation artefact. The mesosporia are quite often different in shape or smaller in size than the spore cavity. At ultrastructural level the arrangement of sporo-pollenin units in the mesosporia is also different from that in the sexine or ektexine or perine. Therefore, we regard the absence or presence, and in the latter case the nature and organisation, of the mesosporium to be a very important taxonomic character.

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EXPLANATION OF PLATES

(All figures × 200, unless mentioned otherwise)

Noniasporites harrisii gen. et sp. nov.

PLATE 1

1. The holotype in dry condition, as seen under transmitted light.
2. The holotype after differential maceration. BSIP slide no. 6998.
3. Proximal view of another differentially macerated megaspore showing an incipient trilete tetrad mark and a number of rill-like features in the inter-ray areas. BSIP slide no. 6999.
4. Lateral view of a differentially macerated megaspore. Note that the distal surface of the megaspore is free of rill-like structures. BSIP slide no. 6970.
5. A thin section of a megaspore showing acavate nature. The rays of the triete mark are pointed by arrows. BSIP slide no. 6971.
6. TEM micrograph of the megaspore sporoderm showing its homogeneous nature.
7. Thin section of a megaspore of *Isoetes coromandelina* L. showing distinct separation of nexine from sexine. BSIP slide no. 6972.

PLATE 2

8-11. SEM micrographs of megaspores in different views. The arrows in fig. 9 point out the triradiate ridges.

12. SEM micrograph showing surface topography of inter-ray area of the megaspore illustrated in fig. 10, × 1000.

13. SEM micrograph showing surface ornamentation of megaspore illustrated in fig. 11, × 2,700.

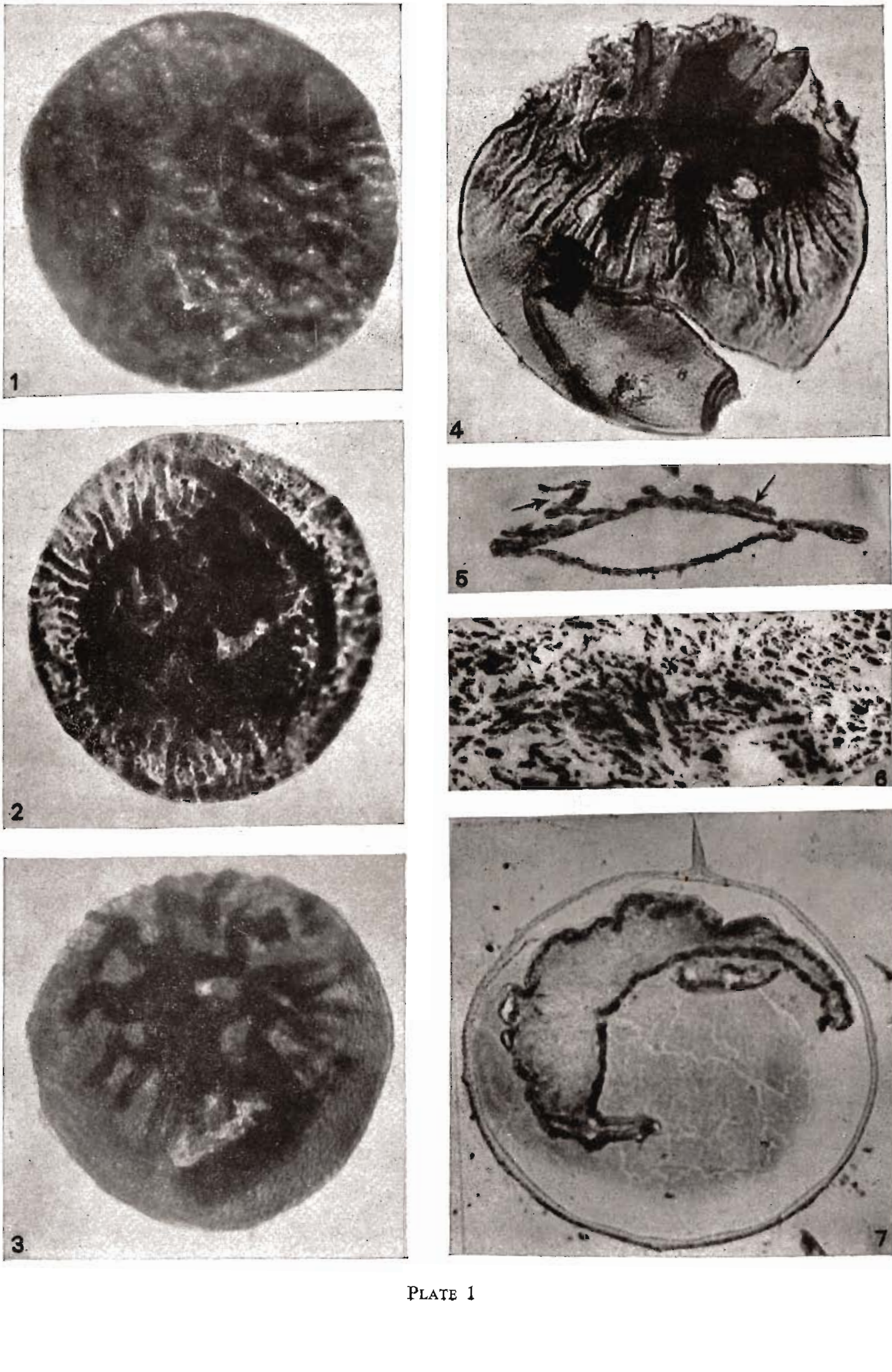

PLATE 1

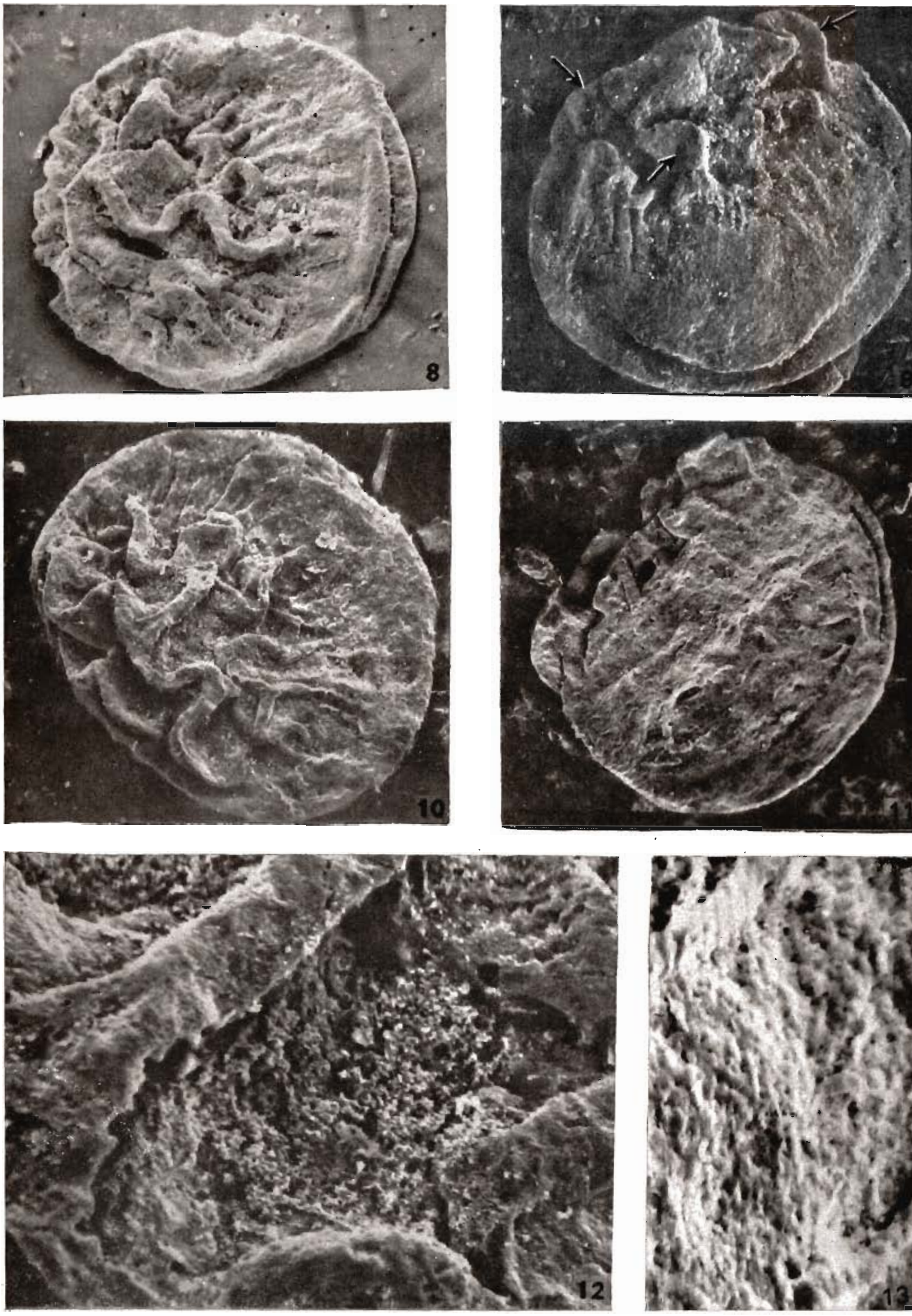

PLATE 2