

# A NEW ASSEMBLAGE OF FOSSIL PLANTS FROM THE RAJMAHAL HILLS : SPORANGIA AND SEEDS\*

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## ABSTRACT

In the present paper description of fertile organs i.e. sporangia and seeds are given from a new locality of Rajmahal hills. Sporangia are schizeaceous with *Liratosporites* type of spores. Seeds are found isolated and grouped tentatively into four types on the basis of size and nature of integument. In all the seeds, nucellus is free from integument.

## INTRODUCTION

The Jurassic rocks of the Rajmahal Hills are well known for the collection of fossil plants. The main constituents of the flora are ferns, cycads, Bennettitales, Pentoxyleae and conifers (OLDHAM & MORRIS, 1863; FEISTMANTEL, 1877; SAHNI & RAO, 1931; GANJU, 1946; GUPTA, 1954; BOSE, 1966; SHARMA, 1974). In addition, there are known a few lycopods, *Equisetites*, *Thinnfeldias* and *Ginkgoites* (SRIVASTAVA, 1945; SAH & JAIN, 1965; SHARMA *et al.*, 1971). During a recent visit to the Rajmahal Hills the senior author (BDS) discovered a new locality possessing a peculiar assemblage of petrified plants. This locality is situated four kilometers North West of the railway station Pakur in the Santhal Pargana District of Bihar. The fossiliferous rock rests on a thick layer of trap. Plant fossils are preserved as petrifications.

Slides were prepared by the usual grinding and polishing process and mounted in canada balsam. Sometimes, canada balsam made the section so transparent that the cellular details disappeared; in such cases the sections were examined under a water film. Maceration was also tried but could not get fruitful results.

## DESCRIPTION

The new assemblage of plants found in the locality of Pakur includes stems, roots, petioles, sporangia, seeds and megastrobili belonging to leptosporangiate ferns, pteridosperms and conifers (SHARMA, 1975; SHARMA & BOHRA, 1976a). However, in the present paper descriptions of sporangia and seeds are given.

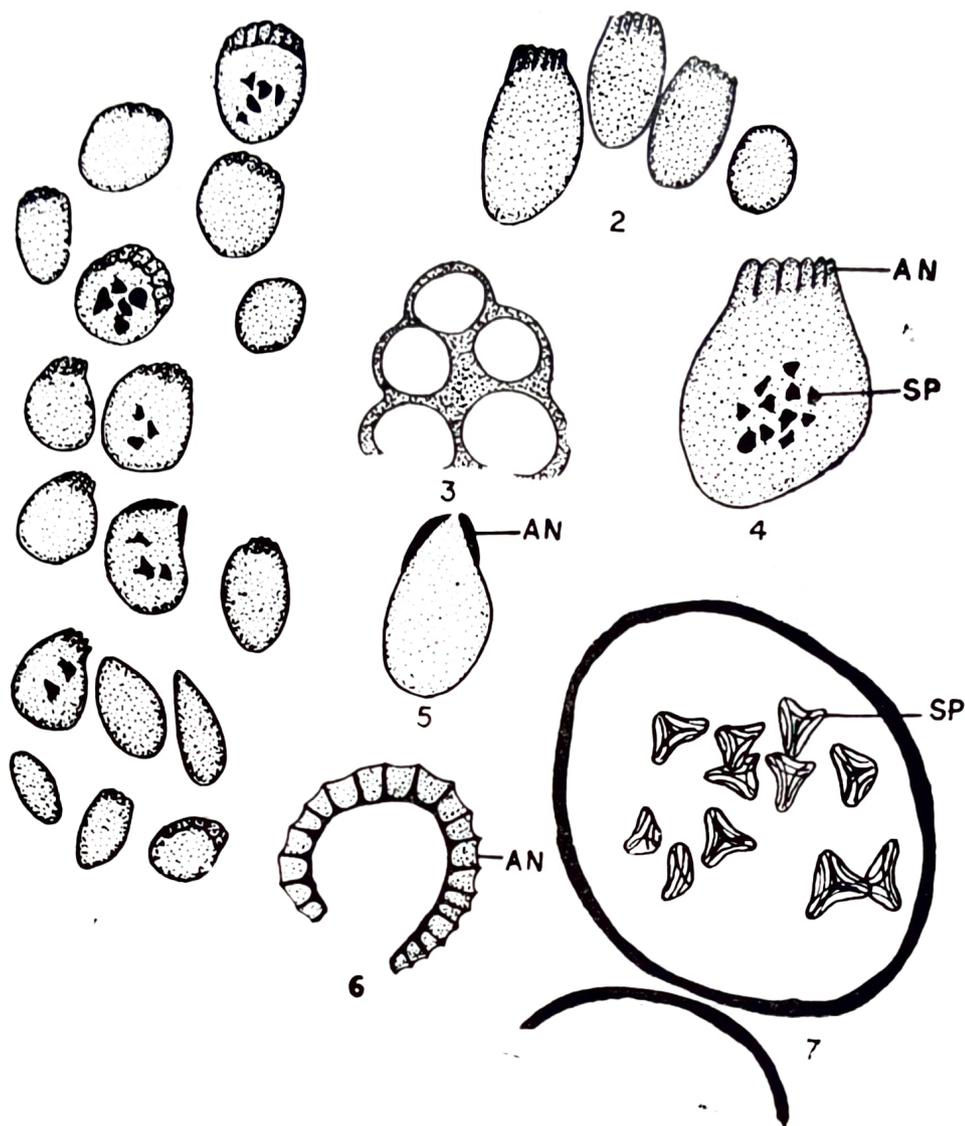
## SPORANGIA

These are found isolated (Text-figs. 4 & 5) as well as in groups giving the appearance of linear sori (Text-fig. 2) or are arranged in several rows in a spike (Pl. 1, Fig. 1; Text-fig. 1). Sometimes, they are placed so closely to each other as if their walls are fused forming a synangium (Text-fig. 3). Sporangia are stalkless, massive, 320—400 × 140-220 μ in size with a single cell thick wall (Pl. 1, Fig. 2). Wall cells are parenchymatous except the annular cells which are comparatively thick walled and dark in colour (Text-fig. 6). In position the annulus is schizeaceous, present surrounding the apical part of sporangium (Pl. 1, Fig. 2; Text-figs. 4 & 5). Stomium is distinct.

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Sporangium is filled with 48-64, trilete spores which are  $44 \times 40 \mu$  in size and provided with intersecting parallel muri or striations (Text-fig. 7). Triradiate mark is also present.



Text-figs. 1-7. Sporangia in different views. 1. Sporangiferous spike, 2. Linear sporangia, 3. Closely placed sporangia, 4. A massive sporangium, 5. L. S. sporangium, 6. Annulus, 7. Spores ( $1-5 \times 24$ ,  $6 \times 60$ ,  $7 \times 250$ ). (AN—Annulus, SP—Spores)

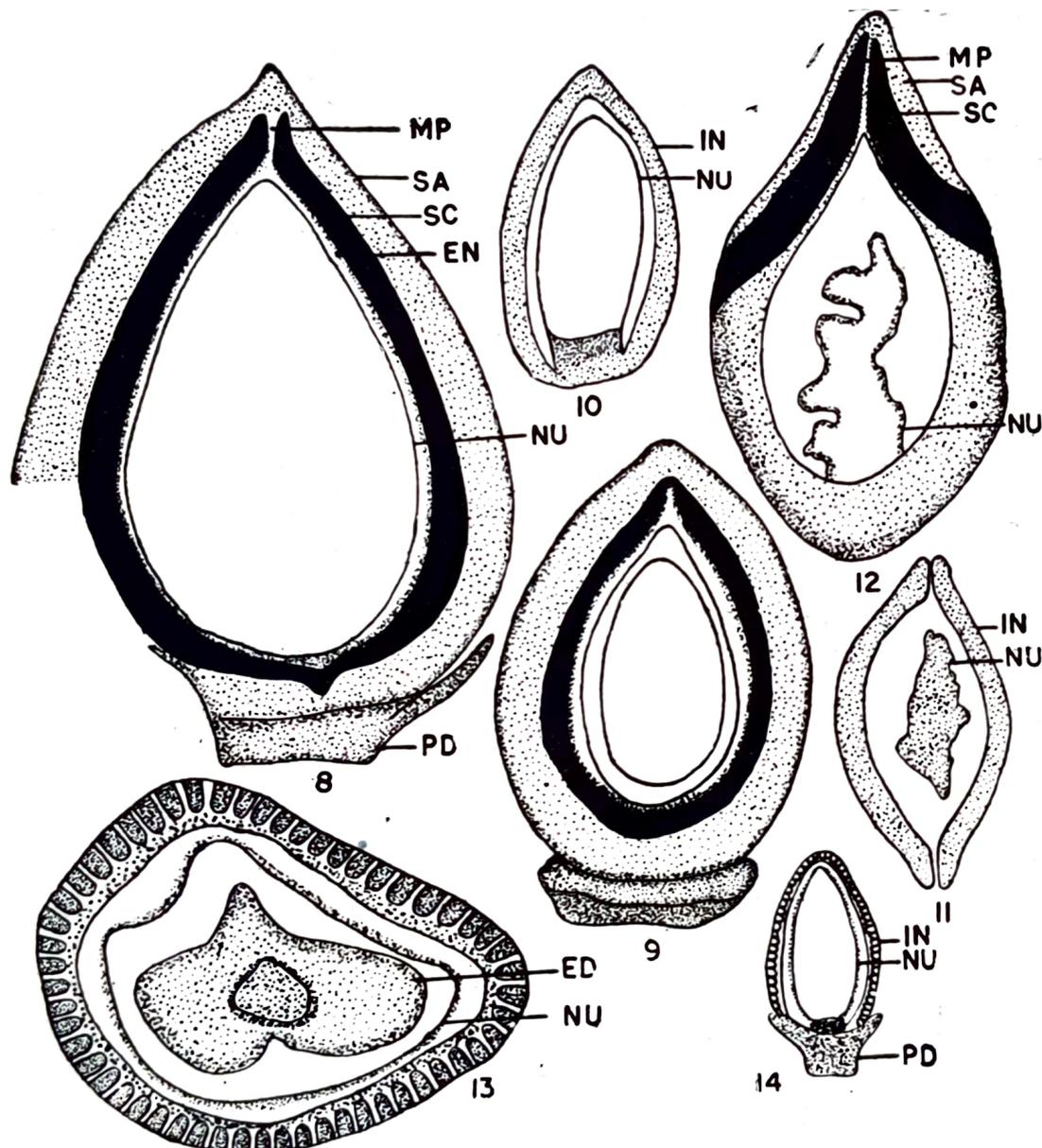
The present material resembles the isolated 'Sori Type 2' described by MITTRE (1959, Pl. 2, Fig. 11, p. 153) from *Nipania* in the Rajmahal Hills, in the linear arrangement of sporangia containing trilete spores but differs in other characters like the shape, size and position of annulus in the sporangium.

Comparison is also made with the spores of the genus *Cicatricosisporites* described by VENKATACHALA (1969, Pl. 1, Fig. 32) from Umia Beds of Cutch. But nothing is known about the sporangia and other details in the latter.

Isolated seeds are found frequently in the present rock. These are seen embedded in different planes. They are of different size and shape and show variations in their internal structure. Tentatively, all these seeds are grouped into four types in the present paper.

## SEED TYPE A

Seeds large, ovoid or rounded,  $5.5 \times 4.2$  mm in size, pedicellate or sessile. Pedicel small with laterally expanded terminal part forming a collar or reduced cupule-like structure (Text-figs. 8, 9). But generally the seeds are found detached and without pedicel. Integument is thick and differentiated into three layers i.e. sarcotesta, sclerotesta and endotesta (Pl. 1, Figs. 3, 4; Text-figs. 8, 9). Sarcotesta is comparatively wider and made up of large rectangular, transversely placed parenchyma (Pl. 1, Fig. 4). Sclerotesta is also well developed and made up of thick walled cells. They are also transversely oriented. Endotesta is comparatively narrower and generally not preserved (Pl. 1, Fig. 4). It is made up of thin walled parenchyma. Micropyle is short, narrow and formed as a result of protrusion of sclerotesta beyond the sarcotesta.



Text-figs. 8-14. Seeds in various planes. 8 & 9. L.S. Seed Type A. Differentiation of integument layers and pedicel, 10. L.S. Seed Type B. Homogeneous integument and nucellus attachment, 11. Same. T.S. Bivalved integument and shrunk nucellus, 12. Seed Type C. L.S. Long micropyle and shrunk nucellus, 13. Seed Type D. T. S. Palisade-like outer layer of integument, free nucellus and large megagametophyte, 14. Same. L.S. With distinct pedicel. (8-12 and 14  $\times 24$ , 13  $\times 60$ ).

(MP—Micropyle, SA—Sarcotesta, SC—Sclerotesta, EN—Endotesta, NU—Nucellus, IN—Integument, PD—Pedicel, ED—Megagametophyte).

Nucellus is free from integument (Pl. 1, Fig. 4b; Text-fig. 9). It is preserved as a single cell thick layer inside the integument. Neither pollen chamber nor nucellar beak is present. Megagametophyte is large and occupies almost the entire lumen of nucellus.

The material is compared with the medullosean seed *Pachytesta* Brong. (Taylor, 1965) in the nature of integument and free position of nucellus. Like the latter, major part of nucellus is occupied by megagametophyte. But the present seed differs from *Pachytesta* in its small size, non-ribbed integument and absence of distinct pollen chamber. Integument as well as nucellus are generally vascularized in *Pachytesta*, whereas no sign of any trace could be seen in the present seed.

Comparison is also made with the non-ribbed medullosean seed *Stephanospermum* Brong. (Hall, 1954), but the present material differs in the absence of crown-like structure surrounding the micropylar canal in the latter seed. In addition to this character there are other points also on the basis of which the present seed can be differentiated from *Stephanospermum* e.g. non-vascularised integument, absence of pollen chamber etc..

Seeds of Pentoxyleae i.e. *Carnoconites* are also compared with the present material. Like the latter, integument is differentiated into three layers, nucellus is free and without pollen chamber and absence of vascular supply to the integument. But in the former, seeds are comparatively smaller in size and sessile i.e. found directly attached with the mother axis of inflorescence.

#### SEED TYPE B

Seeds small, ovoid, non-pedicellate,  $2.3-2.8 \times 1.4-1.6$  mm in size. Integument is thin, bivalved (Text-fig. 11), homogeneous (Plate 1 Fig. 6; Text-fig. 10) and made up of thin walled hexagonal cells. Vascular supply is absent. Nucellus is free from integument except the basal part with which it is attached with the latter (Plate 1, fig. 6; Text-fig. 10). In some of the seeds nucellus extends laterally and may protrude out through the points of meeting of the two valves of the integument. Pollen chamber is absent. Megagametophyte is large.

The material resembles the seeds of *Carnoconites* Srivastava (1945) in shape, size and to some extent in the internal structure. Like the former, the nucellus is free, pollen chamber is absent and vascular supply not visible. But in *Carnoconites* the integument is differentiated into sarcotesta, sclerotesta and endotesta and seeds are generally found attached with the mother axis or occur in groups. while in the present material integument is homogeneous and found isolated.

#### SEED TYPE C

Seed medium-sized,  $3.2 \times 1.8$  mm in size, ovoid with a pointed micropylar end (Pl. 1, Fig. 5; Text-fig. 12). Basal part is rounded and without pedicel. Integument is thick, homogeneous in the lower half but it is heterogeneous in the micropylar part and made up of outer sarcotesta and inner sclerotesta. Micropylar canal is narrow, long and lined by sclerotesta. Nucellus is free from integument except at the basal part (Text-fig. 12).

Comparison is made with the long micropylar canal bearing medullosean seeds like *Stephanospermum elongatum* (Hall, 1954). Like the latter, integument is non-ribbed, nucellus is free from integument, but unlike *Stephanospermum* the crown and the vascular supply are absent in the present material.

*Pachytesta olivaeformis* also possesses a long micropyle but unlike the present seed the integument is ribbed or winged in the former.

#### SEED TYPE D

Seed small, oblong,  $2.2-2.4 \times 1.2-1.4$  mm in size with a distinct base (Pl. 1, Fig. 7;

Text-fig. 14). Terminal part of pedicel expands laterally and forms a collar-like structure (Text-fig. 14). The seed is triangular in cross section (Pl. 1, Fig. 8; Text-fig. 13). The integument is thin but differentiated into two layers i.e. outer palisade-like layer and inner thin parenchymatous layer. Nucellus is free from integument except at the basal part. Neither pollen chamber nor nucellar beak is seen. Megagametophyte is large and occupies major portion of nucellar space.

Like other seeds described above, it also possesses some of the characters of typical medullosean seeds e.g. free nucellus and differentiation of integument into layers. But small size and absence of vascular supply differentiate the present seed from the latter. For the present this seed can not be easily compared with any of the known fossil material.

## DISCUSSION

The fossiliferous locality of Pakur possesses a peculiar and new assemblage of petrified plants which include leptosporangiate ferns, pteridospermous seeds, coniferous woods and megastrobili. The typical representatives i.e. Bennettitales and cycads of the Rajmahal Flora are absent in the new exposure. Majority of the plants discovered so far (Sharma & Bohra, 1976; Sharma & Bohra, 1976 a) from this locality are new and interesting. However, some of the representatives show similarities with the plants known from the locality of Nipania in the Rajmahal Hills and described by MITTRE (1959) e.g. *Solenostelepteris*, fern petioles and sori. But the vegetation of the latter locality was dominated by the Pentoxyleae which is not seen so far in the new locality.

Though the seeds found in the fossiliferous locality of Pakur are of various shape and size yet they possess some common features like the non-vascularised integument, free nucellus, absence of pollen chamber and all occur isolated and detached from the parent plant. They share the characters of Medullosaceae as well as Pentoxyleae. The bivalved integument in Seed Type B shows affinities with the Cordaitales. But in the latter, seeds are mostly platyspermic while the former is a radiospermic seed.

Sporangia are schizeaceous in having the apical annulus and in the form of spikes. They are generally found in association with the stem of *Solenostelepteris*, but never found in organic connection with the latter. The associated frond is still to be discovered.

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#### EXPLANATION OF PLATE 1

1. L. S. sporangiferous spike. Sporangia in several rows.  $\times 16$ .
2. L. S. sporangium with apical annulus and trilete spores.  $\times 48$ .
3. L. S. Seed Type A. Differentiation of integument layers into sarcotesta, sclerotesta and endotesta.  $\times 16$ .
4. Same (enlarged).  $\times 48$
5. L.S. Seed Type C. Long micropyle and nature of integument.  $\times 16$ .
6. L.S. Seed Type B. Homogeneous integument and nucellus attachment.  $\times 16$ .
7. L.S. Seed Type D. with a distinct pedicel.  $\times 16$ .
8. T.S. Seed Type D. Differentiation of integument layers and free nucellus with large megagametophyte.  $\times 48$ .

