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A REVIEW ON *RUGASPERMUM* PANT & BASU SEED GENUS FROM THE TRIASSIC OF NIDPUR, MADHYA PRADESH, INDIA

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ABSTRACT

The paper embodies description of morphological and anatomical variations in all the reported species of Rugaspermum, R. insigne, R. media, R. obscura, R. minuta and R. stipitatus. All the species of Rugaspermum reported from the same Triassic beds of Nidpur, Madhya Pradesh, India. On maceration the seeds yield four membranes viz., outer, inner, nucellar and megaspore membranes. Pollen chamber of different species of the seed taxon contains striate, unwinged, Rugapites Pant and Basu (1977) type pollen grains that are remotely comparable to the polyplicate pollen types of gnetophytes. Pollination is possibly entemophilous.

Key words: Gymnosperm, *in situ* pollen grains, papillate, *Rugaspermum*, Seed, Triassic.

Introduction

The Nidpur Triassic beds discovered by Satsangi (1964) have yielded a rich haul of fossiliferous plant material assignable to different groups including algae, bryophytes, pteridophytes and gymnosperms. The gymnosperms dominated the scene as the shale is littered with leaves of *Dicroidium* (Gothan, 1912), *Lepidopteris* (Townrow, 1960), *Glandulataenia* (Pant, 1990), occasionally *Glossopteris* (Brongniart, 1828) and a variety of microsporangiate organs including *Pteruchus* (Thomas, 1933), *Nidistrobus* (Bose and Srivastava, 1973a; Bhowmik and Parveen, 2009), *Nidpuria* (Pant and Basu, 1979b; Parveen and Bhowmik, 2016) and *Lelestrobus* (Srivastava, 1984). Besides macrofossils, the beds have also yielded a diverse

collection of well-preserved mesofossils comprising seeds, synangia, and megaspores (Pant and Basu, 1973, 1977, 1979 a & b; Bhowmik and Parveen, 2008,2009, 2012, 2014; Bhowmik and Das, 2011; Bose and Srivastava, 1973; Manik, 1987; Srivastava and Manik, 1990, 1993, 1996).

Several seed genera having one to three species are reported from Nidpur beds but the largest number of species (five) has been recorded in the genus *Rugaspermum* (Pant and Basu, 1977). Moreover, the *Rugapites* Pant and Basu pollen grains recorded in pollen chambers of different species of the seed taxon reportedly resemble grains produced inside the synangiate pollen organ *Rugatheca* (Pant and Basu, 1977). No other seed taxon from the Nidpur assemblage exhibits *Rugapites* type pollen grains within its pollen chamber.

The Nidpur beds occur in the Gopad River section in the western part of Singrauli Coalfield, Sidhi District, Madhya Pradesh, India and are assigned Middle Triassic (245–235 Ma) age. The fossil locality is about two and a half kms north–west of Nidpur village, on the left bank.

Description:

Earlier the seed genus *Rugaspermum* was assigned by Pant and Basu (1977) on the basis of their characteristic features- small size, unwinged, wrinkled surface and pollen grains found inside the pollen chamber is unwinged *Rugapites* type. The robust outer cuticle of integument of *Rugaspermum* may indicate that the seed was fully exposed and not sheltered inside a cupule. They described Three species *R. insigne*, *R. media*, *R. obscura*. Each species showed a characteristic outer cuticle. The transverse ridges in all the three sprcies are formed by bands of crowded prominent papillae on surface cells. *R. insigne* and *R. media* show rather regular transverse ridges but these are somewhat irregular in *R. obscura*.. In *R. insigne* and *R. obscura* outer ccuticle are non papillate but the terminally papillae in the cell produce the wrinkles only one cell high while in *R. media* outer cuticle are medianly papillate and the wrinkles produce by 3-4 row high cells. Moreover the outer cuticle of *R. obscura* is stomatiferous but in *R. insigne* and *R. media* is non-stomatiferous. The inner cuticle of integument is free towards the micropyle but fused below with the nucellar cuticle. Pollen chamber excavated type.

Pant and Basu (1977) compared the *Rugaspermum* seed with other compressed seeds like *Pilophorosperma*, *Spermatocodon* and *Umkomasia* those have curved and bifid micropylar beaks. Moreover, pollen grains found in the pollen chambers of corystospermaceous seeds are always two-winged but the grains inside the *Rugaspermum* seed are of unwinged type.

Recently two new species of *Rugaspermum R. minuta and R. stipitatus* described by Bhowmik and Parveen (2012); Bhowmik et al. (2014) respectively.

The structurally preserved compressed seed of *R. minuta* is platyspermic, orthotropus, and oval- to barrel-shaped with a short beak-like micropyle. The surfaces of the seeds are wrinkled and there is a wide lateral ridge running from the apex to the base on both the obverse and reverse sides. The outer cuticle of the integument is thick and non-stomatiferous and the pollen chamber is disc-shaped.

The new species *R. stipitatus* differs from all earlier described species in having a stipe or stalk like structure at the chalazal end in addition to having a stomatiferous outer cuticle of integument showing medianly papillate cells. The pollen chamber is relatively massive. A comparative table 1 showing structural features of all the species of *Rugaspermum,* described so far from the Nidpur bed.

The two new species of *Rugaspermum R. minuta* and *R. stipitatus* differs from all previously described seeds from the Nidpur beds, like *Savitrispermum*, *Nidispermum*, *Pyriformispermum, Rotundaspermum*, *Pantiaspermum*, *Delevoryaspermum*, *Tayloriaspermum*, *Cupolaspermum, Konaspermum*, *Sahnispermum*, *Urceolaspermum*, and *Chaturvedeacarpon* (Manik, 1987; Srivastava & Manik, 1990, 1993, 1996; Srivastava et al., 2001).

Ever since their discovery, the Middle Triassic shales of Nidpur have yielded a rich variety of plant fossils that include sterile as well as fertile plant organs. Among fertile organs the most well reported taxon is *Pteruchus* Thomas (1933), the male fruiting organ of *Dicroidium*. At least seven species of the genus have been reported so far from the Nidpur beds. Their local species level variation is remotely comparable to the specific variation observed in seeds of *Rugaspermum*. So far five species of the seed taxon have been described from the Nidpur beds. If frequency of occurrence and association are considered to indicate closeness then the two organs would have been assigned to the same source plant *Dicroidium*. But since none of the reported seeds exhibit corystospermous features like being enclosed in cupular enclosures or having curved bifid micropylar canals or exhibiting bisaccate pollen grains inside seed pollen chambers, their assignment to corystosperms is presently not possible. Rather presence of *Rugapites* grains of *sporae dispersae* within the pollen chamber of seeds indicate a gnetalean than a corystospermous affinity. The striate, spheroidal to ellipsoidal, unwinged pollen grains having a characteristically ridged and furrowed ektexine remotely comparable to the polyplicate pollen types of gnetophytes that are believed to have pollinated the Cretaceous seeds of *Ephedra portugallica* and *E. drewriensis* (Taylor et al., 2009).

Besides *Rugapites*, the likelihood of another pollen grain *Weylandites* (Bharadwaj and Srivastava, 1969), of *sporae dispersae* having pollinated the seeds cannot be ruled out as the grains seemingly resemble *Rugapites* in showing a vertically, obliquely or horizontally striated exine (Balme,1995). But *Weylandites* grains have not been reported *in situ* within any pollen organ whereas *Rugapites* grains have been recovered *in situ* within the synangial organ *Rugatheca* (Pant and Basu, 1977) that lies closely associated with the seeds in the Nidpur shales. This fortuitous occurrence suggests the possibility of *Rugaspermum* seeds and *Rugatheca* synangia belonging to the same unknown gymnospermous source plant that probably resembled the Gnetales. The distinctive surface ornamentation in *Rugapites* grains is also suggestive of insect fluid feeding and entomophily as Mesozoic pollen grains like *Classopolis* Pflug and *Vittatina* Luber resembling *Rugapites* grains have been recovered in pollen loads of insects on account of their distinctive surface microstructures (Krassilov et al.2007).

The reported occurrence of several species of the seed genus from Nidpur area indicates fluctuation in the local climate being a possible cause for structural diversity. Long periods of aridity followed by short term humid condition could have been the reason behind the morphological modifications. The seed also shows an endemic distribution pattern for the unknown parent plant because similar seeds have not been reported earlier.

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Table 1: Morphological and Anatomical differences between all the species of

S. No.	Name of species	Seed Size (in mm) and shape L ×B	Surface wrinkles	Shape of Chalazal end	Shape of Micropylar end	Outer cuticle of integument	Integumentary Stomatal apparatus	Nucellar cuticle	Megaspore membrane	Pollen Chamber
1.	***R. insigne***	1-2.5×1-2.2 Broadly oval	Well marked	Tapering, chalazal hole 440 µm wide	Broadly oval with a short micropylar beak	10 µm thick, Cells longitudinally elongated, 46 µm ×13 µm. Sometimes with terminal papilla	Absent	Cells elongated with slightly sinuous periclinalwalls	10 µm thick. Occupying 2/3rd or a major portion of lower half of seed. Cells polygonal	Simple depression
2.	***R. media***	2.5 × 2.0 Broadly oval	Less marked	Tapering, chalazal hole 920 µm wide	Rounded	8 µm thick, Cells isodiametric to polygonal, 36 µm × 13µm, medianly papillate	Absent	Cells elongated with slightly sinuous side walls.	7 µm thick. Covering 2/3rd of total seed area. Cells polygonal	Simple excavation, 234 µm deep

3.	***R. obscura***	2.8 × 2.4 Oval	Obscure	Tapering, chalazal hole 420 µm wide	Constricted	9 µm thick. Cells isodiametric to polygonal, 21 µm × 16.5 µm, non papillate	Present, stomata sunken, haplocheilic, monocyclic, subsidiary cells 5-8 (6), stomatal cavity overarched by thickened papillae	Cells Short or long with deeply sinuous periclinal walls	5 µm thick. Occupying more than ½ of the total seed area. Cells polygonal	Simple excavation, 400 µm deep
4.	***R. minuta***	1-2.0 × 1-1.5 Oval to barrel shaped	Less marked	narrowly rectangular chalazal hole 700 µm wide	Rectangularly ridged, with a short mucronate central micropylar tube	13 µm thick. Cells rectangularly elongated, 63 µm × 15 µm, non papillate	Absent	Cells rectangularly elongated, periclinal walls slightly sinuous	10 mm thick. Occupying a major portion of seed area. Cells polygonal	Shallow, disc-shaped depression or pit
5.	***R. stipitatus***	2 - 3 × 1- 2 Oval to	Less marked	Distinctly demarcated, pedestal	Broadly tapering.	5 µm thick, Cells isodiametric	Present, stomata sunken,	Cells Polygonal with	8 µm thick. Occupying a good	Large, dome-shaped,

		oblong		based, chalazal hole 875µm wide		to polygonal, 30µm × 15µm, most cells medianly papillate	anomocytic type, haplocheilic, subsidiary cells 5-7(6). Rim of pit cavity highly cutinized	straight to sinuous walls	portion of seed area. Cells polygonal to rectangularly elongated	600µm deep.

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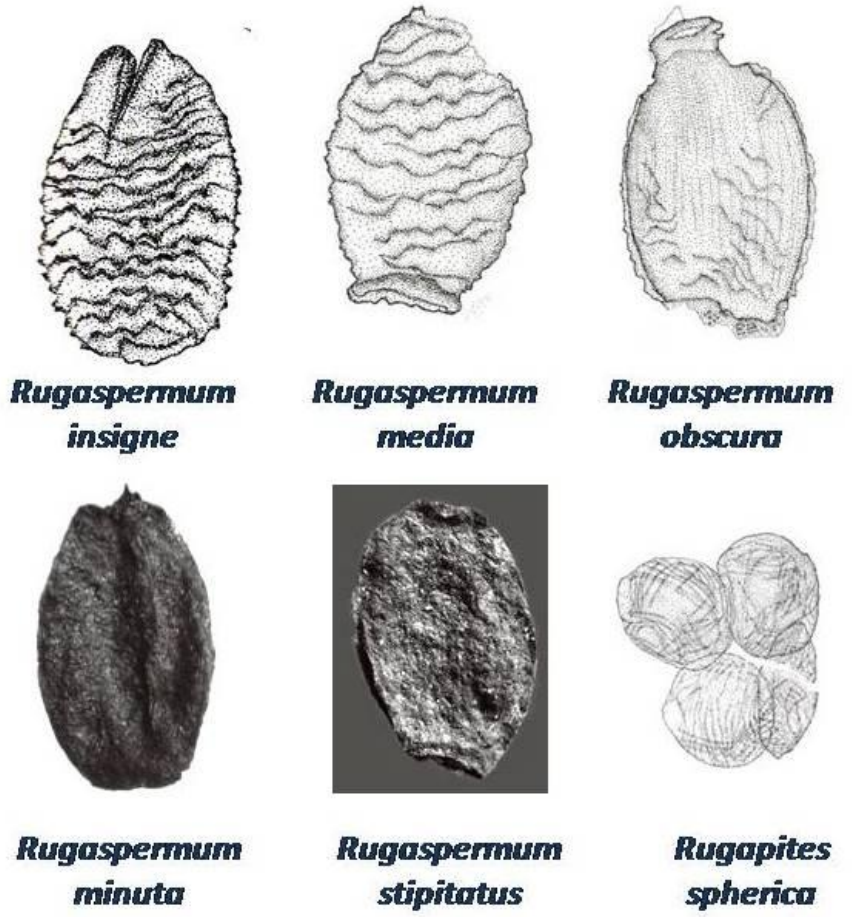

Figure 1: Showing morphological features of all the species of *Rugaspermum* (Pant & Basu, 1977) seed and *Rugapites* pollen grain