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RESEARCH ARTICLE

Rugaspermum stipitatus – A New Species of the Seed Genus *Rugaspermum* Pant & Basu from the Triassic of Nidpur, M. P., India

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ABSTRACT: The paper embodies description of a new species of the dispersed seed taxon *Rugaspermum* (Pant and Basu, 1977), *R. stipitatus*, from the Triassic beds of Nidpur, M.P., India. The new species is distinct from earlier described ones (*R. insigne, R. media, R. obscura* and *R. minuta*) in exhibiting a prominently demarcated wide stalk like rim at the chalazal end. The micropyle is short, tubular and not markedly protuberant. Seeds are about 3 mm long × 2 mm wide, orthotropous, platyspermic, oblong to oval with broadly tapered ends. Seed surface is rough often appearing wrinkled. On maceration the seeds yield four membranes viz., outer, inner, nucellar and megaspore membranes. Outer cuticle is papillate and stomatiferous. Inner cuticle is thin and delicate. Nucellar membrane is free above forming a large dome shaped pollen chamber but fused to megaspore membrane at base. Pollen chamber containing striate, unwinged, *Rugapites* Pant and Basu type pollen grains that are remotely comparable to the polyplicate pollen types of gnetophytes. Megaspore membrane is thick, dark and wide. 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), *Nidpuria* (Pant and Basu, 1979b) and *Lelestrobus* (Srivastava, 1984b). 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, 2012, 2014; Bhowmik and Das, 2011; Bose and Srivastava, 1973; Manik, 1987; Srivastava and Manik, 1990, 1993, 1996).

Seeds compressed in primary as well as secondary planes are abundantly represented in the macerated residues. 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.

Geology

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 downstream (24˚ 7′: 81˚ 54′) along the course of Gopad River. The Nidpur beds occur near the central part of South Rewa Basin in a small fault bounded outcrop (Srivastava, 1974a, text-Fig.1.; Raja Rao, 1983). The lithological succession is comprised of carbonaceous sandy shales of dark and light grey colours with micaflakes, superposed by unfossiliferous massive sandstone consisting of micaceous, ferruginous, fine to coarse-grained sand (Bharadwaj and Srivastava, 1969).

MATERIAL AND METHODS

The compressed seeds comprise a small portion of the enormous plant litter lying scattered in the shales along the bank of Gopad River near Nidpur village, Marhwas area, Sidhi District, Madhya Pradesh, India. The carbonized specimens are structurally preserved with their original three–dimensional form slightly flattened. The seeds were extracted out of the rock matrix after dissolving the shale in 40% hydrofluoric acid. The carbonized plant residue accumulated at the

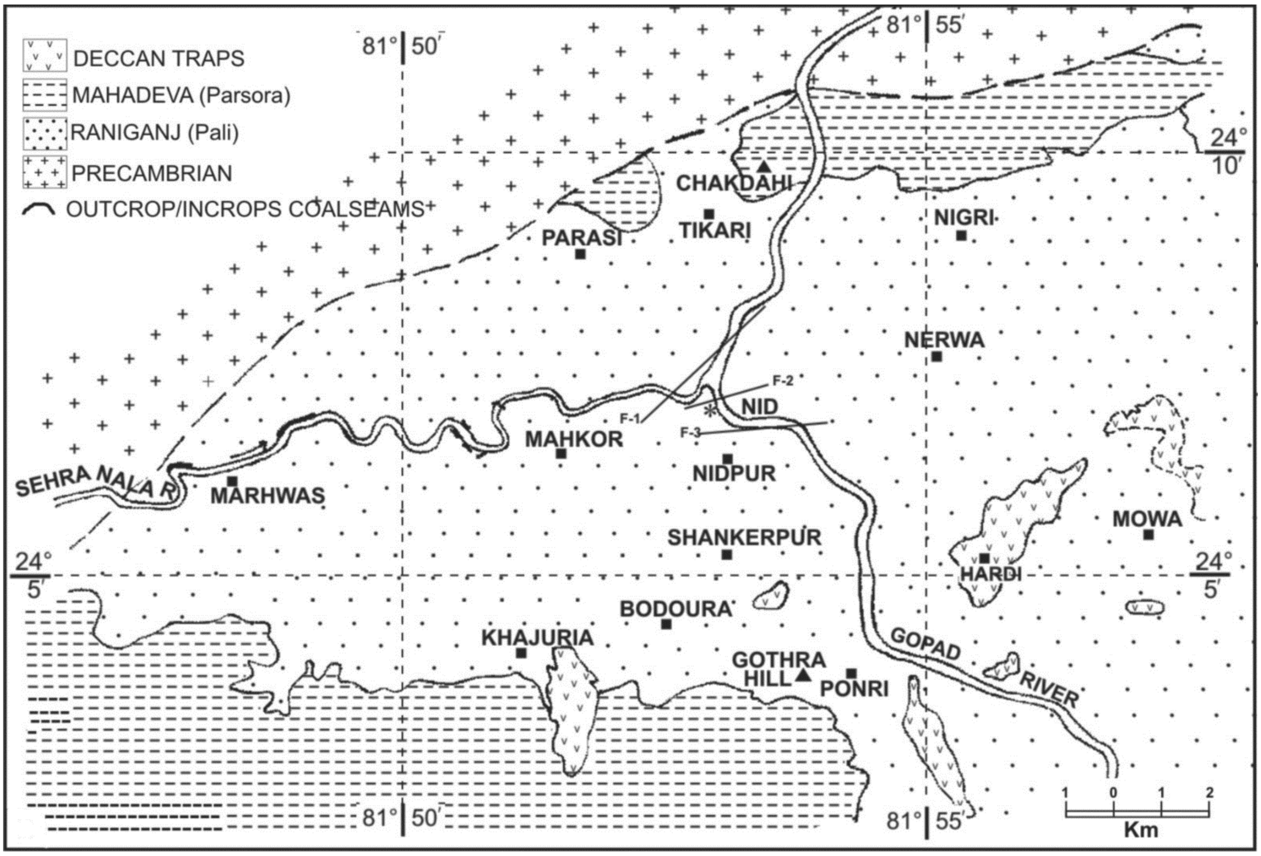

Fig. 1. Map of the study area. Geological map of north–west position of Singrauli Coalfield showing Marhwas area, where the Nidpur beds (asterisk) are situated.(after Raja Rao, 1983).

bottom of the container was repeatedly washed in distilled water to remove the hydrofluoric acid. The residue was then examined under a stereo–binocular (OLYMPUS SZ61) for sorting out the seeds. The selected seeds were air dried and mounted on cavity slides for observation. External features including surface details were observed under unilateral incident light. Some extracted seeds were later subjected to further maceration in Schulze's fluid so that anatomical features could be revealed. The macerated specimens were dissected layer by layer, revealing cuticles of integuments enclosing the ovule. The cuticles and remaining part of the seed were then mounted on a glass slide in safranin stained glycerine jelly. The mounted slides were later examined under Trinocular microscope (OLYMPUS CH20i). Photographs of the seeds were taken with a Wild Leitz microscope, Leica DM 2500 microscope and SONY DSC–W70 Digital camera.

Systematic palaeobotany

Class Gymnospermopsida
Order ? Gnetales
Incertae sedis
Genus ***Rugaspermum*** Pant and Basu, 1977
Rugaspermum stipitatus nov. sp.

Fig. 2 & Fig. 3

Derivation of the name: The specific name *stipitatus* has been given after the stalk-like chalazal end of seed .

Holotype: Slide No.53, 312.

Type Locality: Nidpur village, Marhwas area, Sidhi District, Madhya Pradesh, India.

Age: Middle Triassic (Anisian-Ladinian).

Remaining material: Specimen no. 53, 341–53, 361. The material is deposited in the Divya Darshan Pant collection, Botany Department, University of Allahabad, Allahabad, India.

Diagnosis – Seeds 2–3 mm long × 1–2 mm wide, orthotropous, platyspermic, oblong to oval with broadly tapered ends. Chalazal end is stalk like, about 875 µm wide. Seed surface is rough, often showing oblique to transverse wrinkles. Margin of seeds is entire, faintly serrate. Maceration of seed yields four cuticles. Outermost is thin, about 5 µm thick and stomatiferous showing longitudinal rows of isodiametric to polygonal frequently papillate cells. Stomatal distribution is irregular showing higher frequency at centre than seed base and apex. Stomata anomocytic, transversely to longitudinally orientated, subsidiary cells 5-7 (6) resembling epidermal cells. Guard cells sunken, about 12 µm long × 2 µm wide, walls thinly cutinized, stomatal pore elliptical averaging 10 µm long × 2 µm wide. Inner cuticle of integument is delicate. Nucellar cuticle about 6 µm thick, free above, fused to inner cuticle below. Pollen chamber large, dome-shaped about 600 µm deep containing irregularly scattered striate, unwinged *Rugapites* type pollen–grains. Megaspore sac 1.5 mm long × 1.2 mm wide, dark coloured, tough averaging 8 µm in thickness, showing a flattened to excavated apex, free above, fused to nucellar cuticle below. Cells polygonal averaging 45 µm long × 30 µm wide.

Description

The description of *R. stipitatus* nov. *sp.* is based on a study of more than fifty dispersed seeds extracted out of the rock matrix after macerating the shales in hydrofluoric acid. The seeds are orthotropous, slightly flattened in the principle or secondary planes showing distortion to some degree. They are small, about 2–3 mm long and 1–2 mm wide, oblong to oval, tapering to a broadly rounded apex. In a large number of seeds the chalazal end is distinctly demarcated from rest of the seed body by a broad concavo–convex stalk–like rim bordering an elliptical chalazal hole about 875 µm wide (Figs. 2A–E, G, H). Incident light illumination of well-preserved dry seeds reveal a rough surface often showing transverse to oblique irregular wrinkles, more concentrated near the central and chalazal end than elsewhere (Figs. 2A, C& E). The margin is generally smooth but some naturally macerated seeds appear obscurely serrate on account of the median papilla in marginal cells of outer cuticle of integument (Figs. 2E, F, H). The structure of *R. stipitatus* is revealed by macerating individual seeds in Schulze's solution. Each seed yields four distinct membranes viz. outer and inner cuticles of integument, nucellar and the megaspore membranes respectively. The outer cuticle of integument is apparently free as it can be readily detached from the rest of the seed (Fig. 2H). It is stomatiferous, showing irregularly distributed anomocytic stomata more concentrated at centre than the base and apex (Fig. 2I). Stomata transversely to longitudinal orientated showing an elliptical stomatal pore. Guard cells obscurely visible, sunken having thinly cutinized walls. Subsidiary cells 5-7 (6) thin walled and similar to the epidermal cells but walls of subsidiaries overarching the stomatal pit/cavity are thickly cutinized forming a stomatal rim around the shallow, rectangular 20 µm long × 10 µm wide pit cavity (Figs. 3G& H). The epidermal cells arranged in longitudinal rows are thin walled, rectangular to polygonal in shape, averaging 35 µm long × 10 µm wide, frequently showing a small median papilla (Fig. 3G& H). In a number of seeds the outer cuticle of integument becomes folded at the micropylar end often overlapping the short micropylar tube which is rendered almost obscure (Figs. 2F, H& Fig. 3D)

The remaining membranes are free above but fused to various membranes below (Figs. 2 F-H). The inner cuticle of integument is fused with nucellar cuticle below. It is delicate about 3 µm thick and granular. The cell outlines are obscure, apparently polygonal averaging 25 µm long × 15 µm wide (Figs. 2F& H). The inner cuticle of integument is modified in the anterior region to form a short micropylar tube. The orifice of the tube is often dilated like a funnel showing a thickened border (Figs. 2F, G& Fig. 3A).

The massive nucellus is free from integumentary cuticles at the apical end and modified to form a large dome–like pollen chamber about 600 µm deep. At the base it is wide and fused to inner cuticle of integument and megaspore membrane (Figs. 2F-H). It is tough and resistant showing polygonal cell outlines measuring 35 µm long × 10 µm wide (Fig. 3J). The pollen chamber contains a large number of irregularly scattered, *Rugapites* Pant and Basu pollen grains of variable sizes ranging from 30–60 µm long ×17–55 µm wide (Figs. 3A, C-F). Structural features of pollen grains are often obscured by the overlapping inner and outer cuticles of integument (Figs. 3A & C-F). *Rugapites* (Pant and Basu, 1977) grains of the *sporae dispersae* are reportedly present in pollen chambers of all the species of *Rugaspermum* (Pant and Basu, 1977, Bhowmik and Parveen, 2012). The dispersed grains display distinctive surface features like taeniae and rimulae considered to be insect dispersal features and may be classed among the "charismatic" pollen grains of Krassilov *et al.* (2007). The grains are striate, unwinged, sphaeroidal to ellipsoidal having characteristically ridged ektexine. They apparently resemble the palynomorphs of *Classopolis* Pflug(1953), *Vittatina* Luber (1938) and *Weylandites* Bharadwaj and Srivastava(1969) occurring in strata ranging in age from Permian to Tertiary (Pant and Basu, 1977). Incidently, *Rugapites* grains have also been reported inside the synangiate pollen organ *Rugatheca* Pant and Basu, occurring in close association with the seeds and were probably borne by the same source plant as *Rugaspermum*. In some macerated seeds, including the holotype, occasionally, few bisaccate pollen grains may be found sticking to the inner or outer cuticles of integument in addition to the *Rugapites* pollen grains contained inside the pollen chamber (Fig. 3D). Such grains are believed to be foreign as they have not been reported inside the pollen chamber of any other

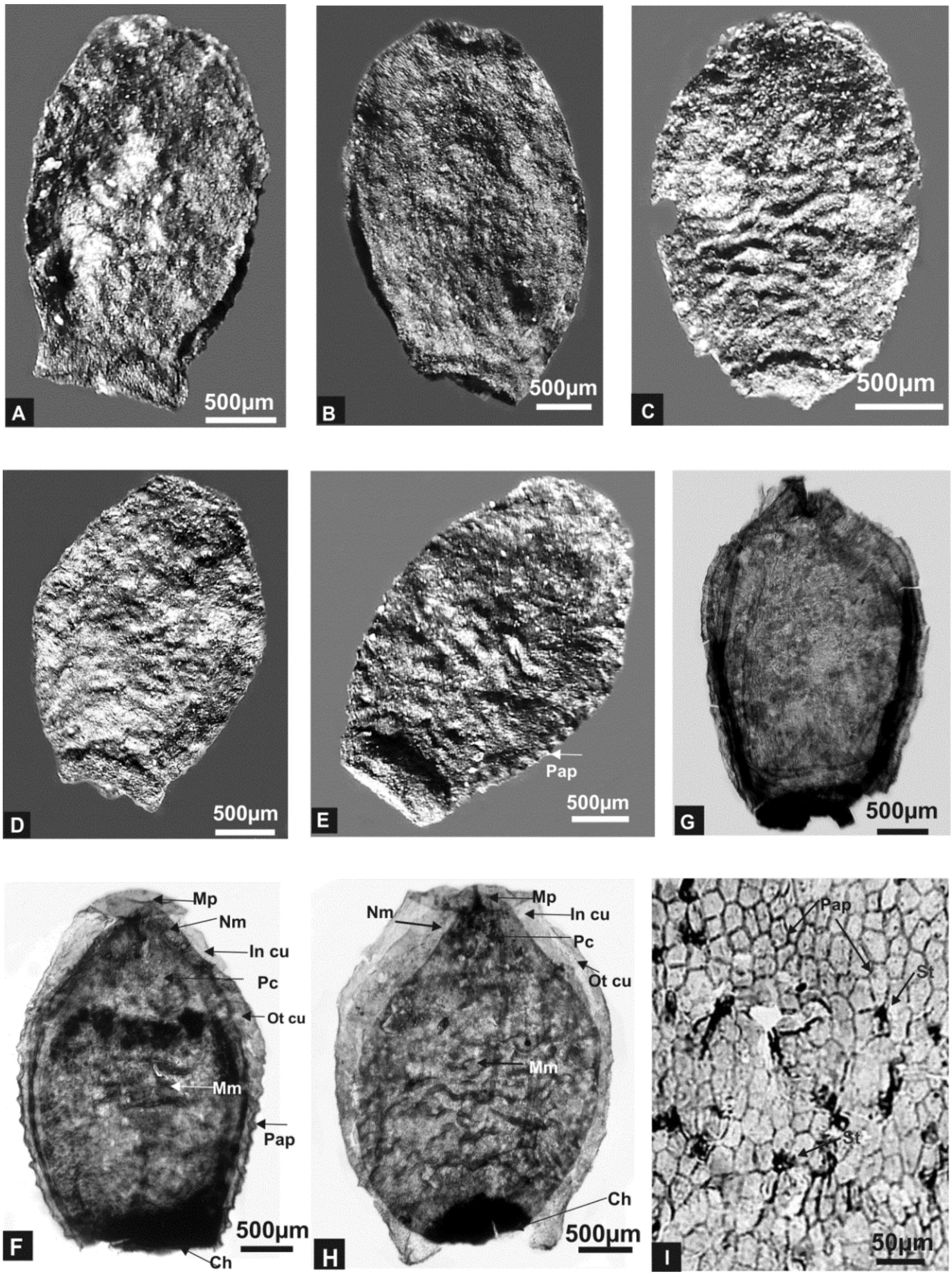

Fig. 2. Compressed dry seed specimens of *Rugaspermum stipitatus* nov. sp. from the Triassic of Nidpur, India. A: Holotype showing a rough and wrinkled seed surface and a stalk like chalazal end. Slide No.53, 312; B, C, D & E: Other structurally preserved oblong to oval seeds showing smooth to wrinkled surfaces and stalk-like chalazal ends. Slide Nos. 53, 341; 53, 349; 53, 351; 53, 348; F, G: Macerated undissected seed specimens showing intact micropylar and chalazal ends and different integumentary layers. Seed in Fig. F, magnified to show a serrated margin. Slide Nos. 53, 357; 53, 358; H. Partially macerated holotype seed showing the free outer cuticle of integument folded over the short micropylar tube apically and various integumentary layers. The micropyle, pollen chamber and chalazal hole are also visible. Slide No. 53, 312; I. Portion of outer cuticle of integument in Fig. 3G, magnified to show medianly papillate cells and stomata. Pc, Pollen chamber; Mm, Megaspore membrane; Nu, Nucellus; Ot cu, Outer cuticle; Mp, Micropyle; In cu, Inner cuticle; Ch, Chalaza; Pap, Papilla; St, Stomata.

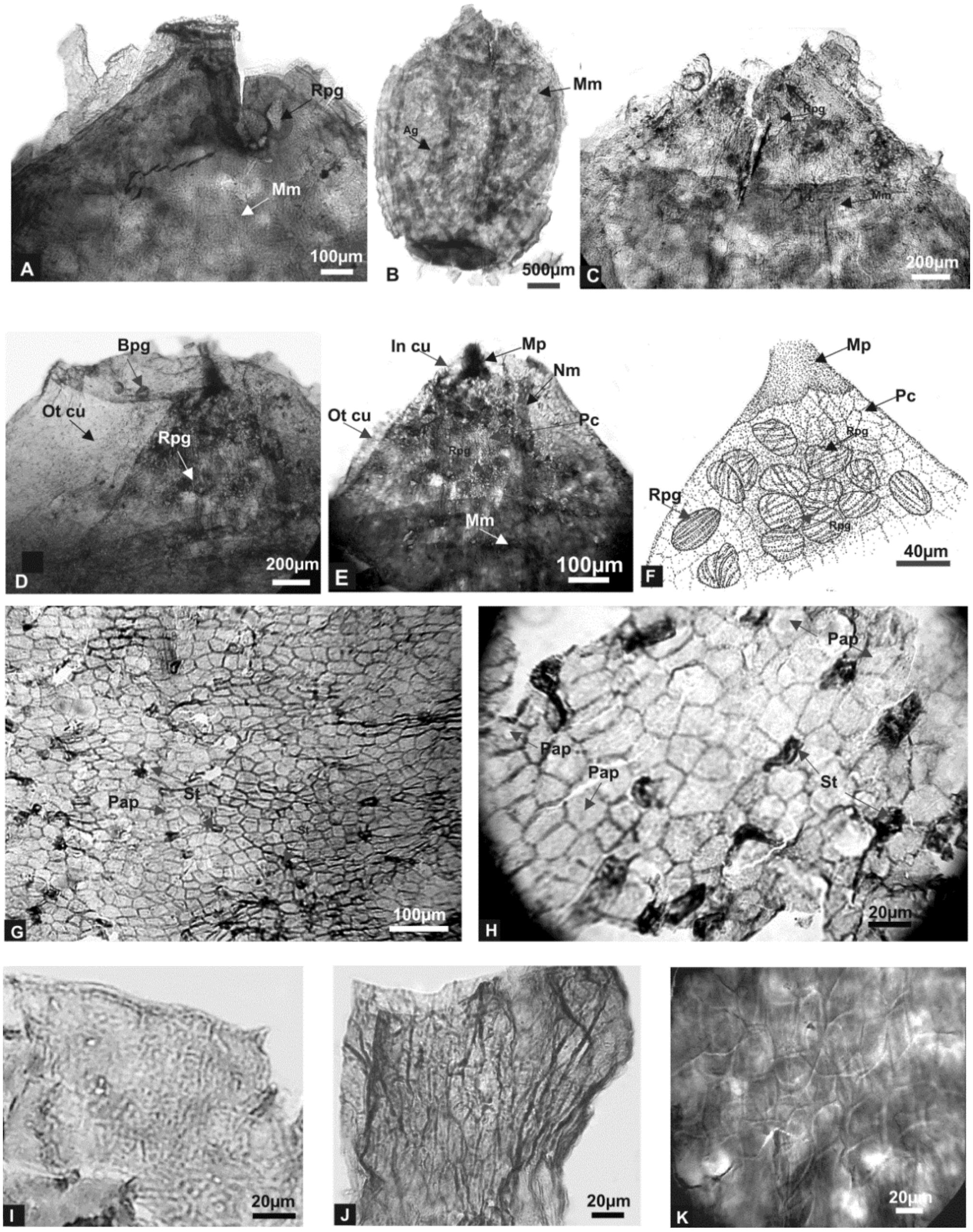

Fig. 3. Structural details of macerated seeds of *R. stipitatus* from the Triassic of Nidpur, India. A: Micropylar end of the seed in Fig. 2G, further magnified to show the funnel-like micropylar tube, adhering outer cuticle of integument and pollen chamber containing *Rugapites* grains. Slide No. 53, 358; B: A macerated seed showing a probable archegonium in megaspore membrane. Slide No. 53, 360. C: Micropylar end of seed in Fig.3B more enlarged to show pollen chamber, *Rugapites* grains and megaspore membrane. Slide No. 53, 360. D: Micropylar end of macerated holotype further magnified to show two bisaccate pollen grains sticking to the folded outer cuticle near the micropyle and a dome shaped pollen camber containing *Rugapites* grains. Slide No. 53, 312; E: Micropylar end of another seed magnified to show the pollen chamber containing *Rugapites* grains, micropyle, nucellus, outer cuticle and inner cuticles of integument and megaspore membrane . Slide No. 53, 361; F: Line diagram of magnified micropylar end of the seed in Fig. 3E, showing striate, unwinged *Rugapites* pollen grains in the pollen chamber. Slide No. 53, 361; G: Outer cuticle of integument of holotype showing papillate cells and distribution of stomata. Slide No. 53, 312; H: Portion of outer cuticle in Fig. 3G, more magnified to show stomata and epidermal cells. Slide No. 53, 312. I-K: Portion of inner, nucellar and megaspore membrane cuticles respectively of holotype magnified to show cell outlines. Slide No. 53, 312. Pc, Pollen chamber; Mm, Megaspore membrane; Nu, Nucellus; Ag, Archegonium; Rpg, *Rugapites* pollen grains; Ot cu, Outer cuticle; Mp, Micropyle; In cu, Inner cuticle; Pap, Papillae; St, Stomata; Bpg, Bisaccate pollen grains.

species of *Rugaspermum*. Microfloral remains of the Triassic assemblage abound in bisaccate grains dispersed from pollen organs like *Pteruchus* (Thomas), *Nidistrobus* (Bose and Srivastava) and *Nidianthus* (Bhowmik and Parveen) and the possibility of such wind dispersed grains getting stuck to the seed cuticles cannot be ruled out.

The megaspore tissue is massive appearing to occupy 1/2 to 2/3 area of the seed (Figs. 2F-H& Fig. 3B). It is dark brown in colour showing a flattened to excavated apex and a flattened base. It is free above but adherent to the nucellar membrane below. Cells of the megaspore membrane are polygonal, 45 µm long × 30 µm wide, dark coloured and appear to have contained reserve food material (Fig. 3K). Some seed specimens exhibit one or two, deep seated, dark coloured, rounded bodies in the megaspore membrane that probably represent compressed archegonia (Fig. 3B).

COMPARISON AND DISCUSSION

Decades earlier to the present report, several dispersed seed genera like *Rugaspermum* Pant and Basu (1977), *Savitrispermum*, *Nidispermum* and *Pyriformispermum*, Manik (1987) had been reported as mesofossil components from the Nidpur beds. Most of the seed genera had a single species except for the taxon *Savitrispermum* which reportedly has three species and *Rugaspermum* which has five species.A comparative chart showing structural features of all the species of *Rugaspermum*, described so far from the Nidpur beds is presented in Table 1. The new species of *Rugaspermum* 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 in *R. stipitatus* is also relatively massive.

The new species is similar to *Savitrispermum*, *Nidispermum*, *Pantiaspermum* Manik (1987) and *Rostrumaspermum* Srivastava and Manik (1990), reported from the same beds in having an oblong to oval shape but differs from them in having a stomatiferous outer cuticle of integument and a massive pollen chamber containing *Rugapites* type pollen grains. The new seed is also comparable to seed taxa *Delevoryaspermum* and *Sahnispermum* Srivastava and Manik (1993), in having a similar shape and in features of outer cuticle of integument. But the outer cuticle of integument in *Sahnispermum* is reportedly only papillate and not stomatiferous and the micropylar opening somewhat protuberant appearing saucer-shaped. In *Delevoryaspermum* the outer and inner cuticles of integument are reportedly non-adherent to the nucellus whereas in *R. stipitatus* the inner cuticle is fused to the nucellar membrane. Besides, the micropylar end is reportedly bowl-shaped and thickly cutinized in the former but short, tubular and unthickened in the latter.

A comparison of the new species with previously reported species of *Rugaspermum* indicates a remote resemblance to *R. media* and *R. obscura* (Pant and Basu, 1977). It resembles *R. media* in showing similar transversely running irregular ridges or wrinkles on the seed surface and in having a somewhat widened chalazal rim but differs from it in micropylar and cuticular features. While the micropylar canal in both species is short and straight, the orifice of the tube is wide in *R. stipitatus*. The pollen chamber is also massive forming a dome-like structure in the new species while in *R. media* the chamber appears small and excavated. Moreover, there is variation in the structure of outer cuticle also. While it is papillate and non–stomatiferous in *R. media*, it is papillate and stomatiferous in *R. stipitatus*. The new species also resembles the earlier described species *R. obscura* in having a rough surface and stomatiferous outer cuticle of integument but differs in having medianly papillate epidermal cells. Cells of the outer cuticle of integument are non papillate in *R. obscura.*

So far five species (including *R. stipitatus*) of the seed taxon have been described from the Nidpur beds. Eversince 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*. 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

Table 1. A Comparison chart of different species of *Rugaspermum* (Pant & Basu, 1977)

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	10µm thick, Cells longitudinally elongated, 46 µm ×13 µm. Sometimes with terminal papilla	Absent	Cells elongated with slightly sinuous periclinal walls	10µm 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, 36µm × 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 oblong	Less marked	Distinctly demarcated, pedestal based, chalazal hole 875µm wide	Broadly tapering.	5 µm thick, Cells isodiametric to polygonal, 30µm × 15µm, most cells medianly papillate	Present, stomata sunken, anomocytic type, haplocheilic, subsidiary cells 5-7(6). Rim of pit cavity highly cutinized	Cells Polygonal with straight to sinuous walls	8 µm thick. Occupying a good portion of seed area. Cells polygonal to rectangularly elongated	Large, dome-shaped, 600µm deep.

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 plant fossils described so far from Nidpur beds indicate the *Dicroidium* flora of Nidpur being individualistic and not in agreement in composition with any Triassic flora of Peninsular India or other Gondwana continents or of the northern hemisphere. In all probability the flora had originated and developed in an isolated environment as reflected by the varied composition of the fossil assemblage (Srivastava and Prakash, 2000). Palaeoenvironmental conditions during the Triassic have been interpreted as arid to semi arid as Hot house conditions prevailed according to Anderson et al., (1999) and Turner (1999). Many significant structural features of *R. stipitatus* like wrinkled surface, medianly papillate cells, stomata comprised of sunken guard cells surrounded by subsidiary cells showing thickly cutinized radial walls also support existence of xeric environmental conditions. Even some earlier described detached seed genera from the Nidpur floral assemblage like *Delevoryaspermum*, *Konaspermum* Srivastava and Manik (1990), *Pyriformispermum* and *Pantiaspermum* Manik (1987) reportedly display epidermal features like papillae, trichomes, cutinized cell walls and sinuous cellular outlines which are characters considered to have been developed in response to fluctuating climatic conditions (Srivastava and Prakash, 2000). In contrast to the above, a large number of detached seeds like *Savitrispermum*, *Nidispermum*, *Rotundaspermum* Manik (1987), *Cupolaspermum*, *Urceolaspermum* and *Tayloriaspermum* Srivastava and Manik (1990) reportedly exhibit a smooth seed surface and delicate outer membrane indicating the possibility of being produced within sheltered organs, possibly a cupule. Nevertheless, prevalence of xeric surroundings alone could not have resulted in the luxuriant flora of Nidpur. Intermittent moist conditions ensuing after short term rainy seasons could have been the reason behind evolution of new and interesting Nidpur forms. Evidence of brief humid environmental conditions is also supported by the rich haul of bryophytes and lycopsid megaspores reported in the assemblage. The cryptogams were probably occupying protected shady and marshy spots in the forest in Nidpur (Pant and Basu, 1978, 1979a, 1981; Bhowmik and Das, 2011).

Conclusion

The article describes a new species of the seed genus *Rugaspermum* Pant and Basu (1977), *R. stipitatus*, is which characterized by a wide stalk like chalazal end and shows a papillate, stomatiferous outer cuticle of integument thus far not reported in earlier recorded species of the taxon. Another significant feature distinguishing the new species from those described earlier is the occurrence of scattered *Rugapites* type pollen grains within the pollen chamber of seeds. In all other species the grains reportedly occur clustered.

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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