Rostrumaspermum venkatachalae gen. et sp. nov., an archegoniate seed from Triassic of Nidpur, India

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Some carbonized seeds recovered from plant-bearing Nidpur beds are assigned to *Rostrumaspermum venkatachalae* gen. et sp. nov. Evidence of archegonia with short tubular neck favours identity with conifers and settles precisely pineaceous affiliations.

Key-words—Megafossil, Archegoniate seed, Morphology, Triassic (India)

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सारांश

निदपुर (भारत) के त्रिसंधी कल्प से एक स्त्रीधानीयुक्त बीज : रोस्ट्रमास्पर्मम वेंकटाचालाइ नव प्रजाति व जाति

श्याम चन्द्र श्रीवास्तव एवं सुरेन्द्र राघोबा माणिक

निदपुर अश्मित-पादप धारक संस्तरों से उपलब्ध कुछ कार्बनी बीजों को **रोस्ट्रमास्पर्मम वेंकटाचालाइ** नव प्रजाति व जाति से नामांकित किया गया है। छोटी नालाकार गर्दन युक्त स्त्रीधानी की उपस्थिति के कारण ये कोनिफरों से सजातीयता इंगित करते हैं और इनमें भी पाइनेसी कुल से।

CONTINUED investigations of plant-bearing Nidpur beds have yielded a number of carbonized seeds. One of these structurally preserved seeds which is characterized by the occurrence of tubular archegonia at the micropylar end of megaspore sac has constituted the matter for this paper. Of the reported seed taxa (Pant, 1978; Manik, 1988) from Nidpur, namely *Rugaspermum, Savitrispermum, Nidispermum, Pyriformispermum, Rotundaspermum* and *Pantiaspermum*, none has revealed any such feature. However, among the various fossil gymnosperms, only a few members of Glossopteridales, Pteridospermales, Bennettitales (= Cycadeoidales) and Cordaitales have shown archegonia at the apical end of megaspore sac. To add, all living members of gymnosperms are also characterized by the presence of archegonia with an exception of *Welwitschia* and *Gnetum* (Maheshwari & Sanwal, 1963).

Renault (1879) figured archegonia in *Cycadinocarpus angustodunensis* from Permian of France. Since then, Brongniart (1981, in: Seward, 1919) described a definite megaspore membrane surrounding prothallus tissue bearing two archegonia. Later, Seward (1919) dealt in detail the structural features of *Cardiocarpus sclerotesta* Brongniart and showed a well-developed pollen chamber. Below the chamber, the prothallus tissue is prolonged as a blunt, short tentpole along which on each side two small archegonia are located. He also instituted a seed taxon *Rhabdospermum cyclocarpon* and reported the presence of single archegonium through illustrations of megaspore sac (Seward, 1919, fig. 501-C, p. 340). Long (1944) observed three archegonia towards the apical end of female gametophyte around the tentpole in a Palaeozoic pteridospermous seed—*Lagenostoma ovoides* Williamson 1877. Long (1959, 1960) opined that Lower Carboniferous seeds are the first known to contain archegonia, with three archegonia being the most common number. Taylor and Millay (1979) marked a well-developed archegonial cavity in *L. ovoides*.

Since the discovery by Long was highlighted,

Text-figure 1—*Rostrumaspermum venkatachalae* gen. et sp. nov., reconstruction of seed depicting overall shape, various cutinized membranes associated with archegonia; in mid-cut-open to show a part of megaspore sac Ca × 50.

Neely (1951) described *Taxospermum undulatum* and depicted the megagametophyte with one spherical or elliptical archegonium on either side of the low tentpole. In this Pennsylvanian seed, Taylor and Millay (1979) identified a megagametophyte which is well-differentiated into a tentpole and archegonium containing cytoplasmic remnant. The gametophyte of *Pachytesta hexangulata* Stewart 1951 consisted of short tentpole with three archegonia around it. Andrews and Felix (1952) reported tentpole and a two jacketed archegonia in the female gametophytes of *Cardiocarpus spinatus* Graham 1935. Andrews (1961, fig. 13-3B) figured a Lower Carboniferous seed, *Sphaerostoma ovale* Benson 1914, where archegonia can be clearly marked but the author has made no mention of it in the description.

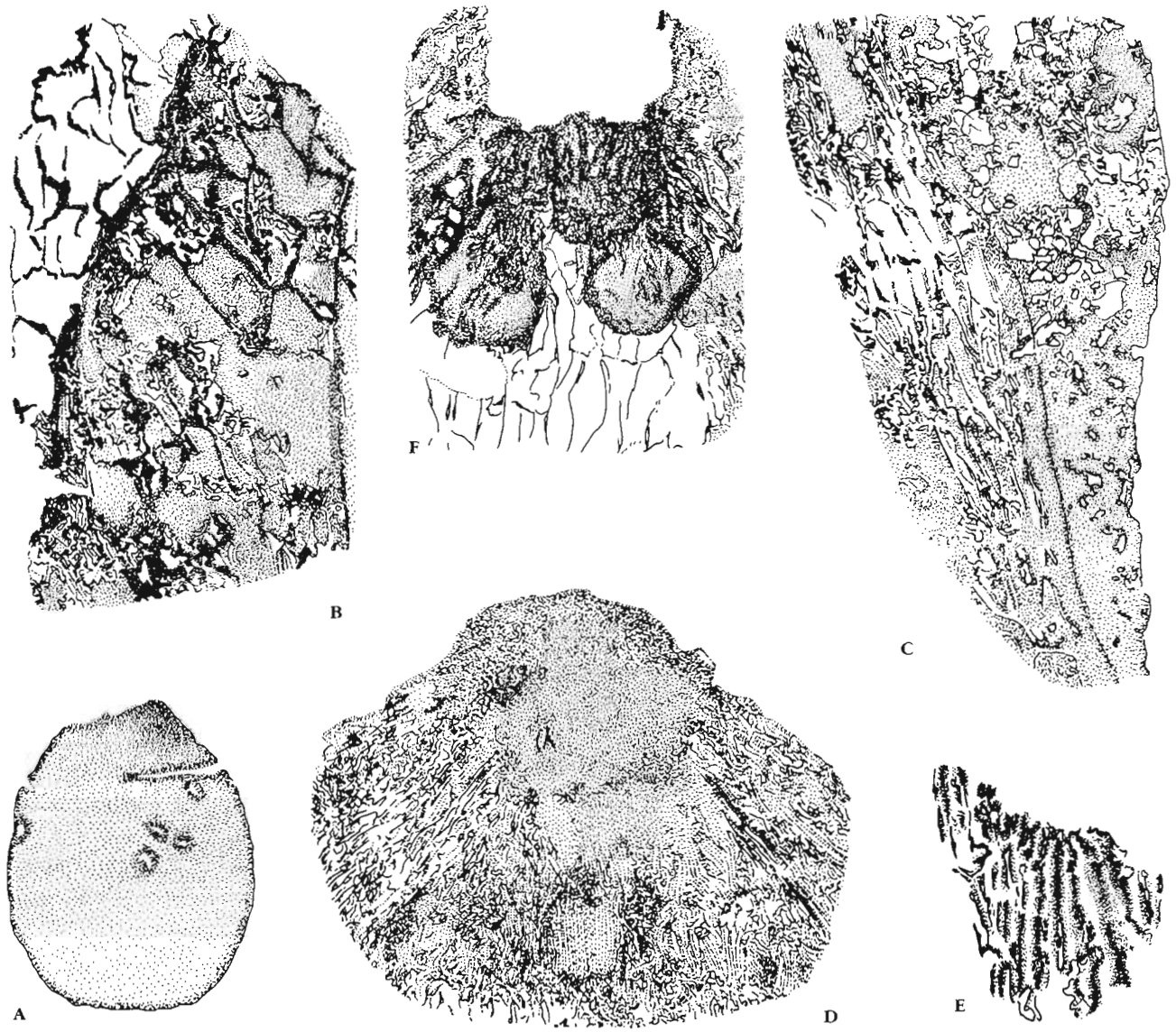
In addition, Rothwell (1971) reported ovoid cavities at the micropylar end of the megaspore sac of *Callospermarion pusillum* Eggert and Delevoryas 1960 and interpreted them to be archegonial cavities. However, in *Callospermarion undulatum,* described by Rothwell (1981), the definitive archegonia could be marked with tubular necks. But distinct number of archegonia could not be marked. In this character of tubular neck, *C. undulatum* approaches closest to the seed described here. Apart from this, Stidd and Cosentino (1976) were able to make out neck canal cells in the sunken archegonia of Carboniferous ovule *Nucellangium* Andrews 1949.

Other than these Palaeozoic seeds from northern hemisphere, interesting records of archegonia have also been made by Pant *et al.* (1985) from the Permian sediments of India. The two seed-genera described are: *Collospermum* and *Palaeocarpus* in which megaspore membrane is raised and prolonged into a tentpole-like structure. Under the surrounding depression, two or three spherical dark bodies are seen which are presumed to be archegonia on the basis of the presence of similar spherical archegonia found in cordaitalean and ginkgoalean seeds. From Late Permian of Bowen Basin, Queensland, Australia, Gould and Delevoryas (1977) have reported glossopteridean megasporophyll bearing seeds containing megagametophyte with one archegonium.

The aforesaid records have demonstrated varied archegonia in petrifactions and compressions of Palaeozoic seeds, but from Mesozoic not much is known. The first record came to light when Lignier (1911) in a reconstruction of *Cycadeoidea (Bennettites) morieri* (Lower Cretaceous of France) illustrated the presence of archegonia in the apical part of endosperm. However, Seward (1919) raised doubt regarding the occurrence of archegonia because the seed of *C. morieri* contains a well developed embryo. Since then, the occurrence of archegonia remained unknown till Sharma (1979), observed 2-3 archegonia in the apical part of endosperm of *Williamsonia*—ovules described from the Mesozoic of Rajmahal Hills, Bihar.

Rostrumaspermum gen. nov.

Diagnosis—Seed ovate, tapering apically somewhat like a snout, micropylar end appearing flattened, integument in outer region thin on flanks and base, tending to be highly developed at apex, forming an outer integument characterized in extremities by radially disposed spaces; cellular structure of integument contorted revealing surface wall interspersed with pits, outer integument closely abutted to nucellus; nucellar membrane thin,



Text-figure 2—*Rostrumaspermum venkatachalae* gen. et sp. nov., **A.** Seed (alkali treated) showing overall outline and chalazal end, Slide no. BSIP 10272, × 25; **B.** A portion of megaspore sac adhered at places with nucellar membrane, Slide no. BSIP 10270, × 250; **C.** A part of micropylar end showing radially disposed spaces interspersed with irregular pits, Slide no. BSIP 10270, × 250; **D.** Apical region of seed exhibiting intensively cutinized flattened micropylar end, Slide no. BSIP 10271, × 150; **E.** A piece of outer integument showing cellular details, Slide no. BSIP 10270, × 250; **F.** Apical region of megaspore sac showing two distinct archegonia, Slide no. BSIP 10270, × 150.

PLATE 1

Rostrumaspermum venkatachalae gen. et sp. nov.

1, 7 Carbonized seeds immersed in glycerine showing overall outline, micropylar and chalazal end (Holotype); Slide nos. BSIP 10270, × 10; 10271, × 10.

2. Acid-treated seed depicting differentiation of cutinized membranes, specimen no. BSIP 10270, × 50.

3. Macerated seed after complete processing showing megaspore sac bearing two archegonia occupying almost entire space of nucellus, Slide no. BSIP 10270, × 25.

4. A portion of seed showing radially disposed spaces interspersed with irregular pits, Slide no BSIP 10270, × 150.

5. Apical end of seed magnified to show two spherical archegonia and distinctly differentiated radially disposed spaces, Slide no. BSIP 10270, × 50.

6 Megaspore sac highly magnified to show two distinct archegonia having tubular neck, Slide no. BSIP 10270, × 300.

8. Seed showing flattened top of micropylar end, Slide no. BSIP 10271, × 50.

9. Terminal portion of seed exhibiting distinctly differentiated nucellar depression, Slide no. BSIP 10272, × 50.

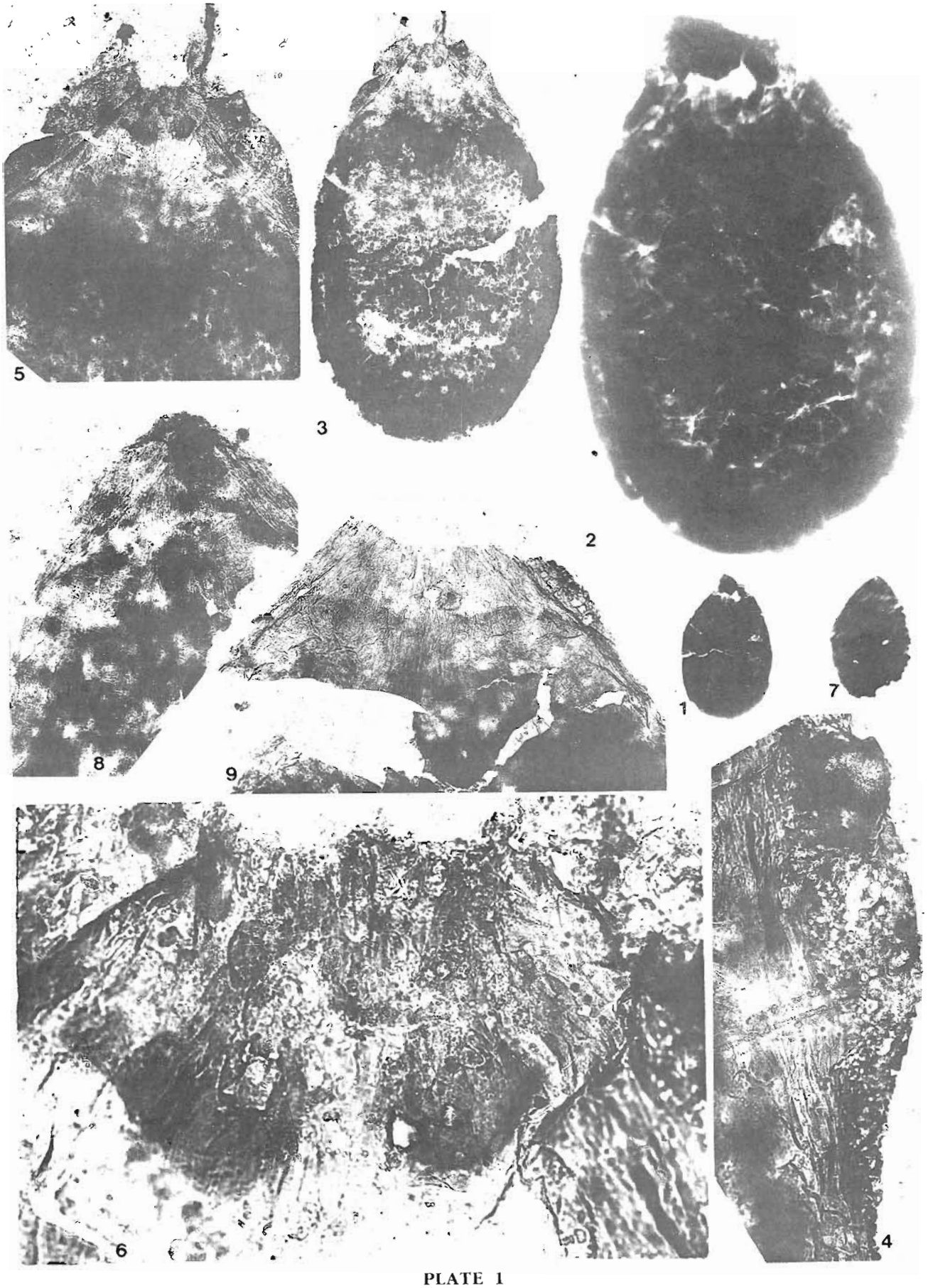


PLATE 1

confluent to megaspore membrane, free from outer integument at its apex; megaspore membrane bearing two archegonia, occupying almost entire space of nucellus, forming ovoid to ovate sac.

Type species—*Rostrumaspermum venkatachalae* sp. nov.

Discussion—In its overall shape the present seed taxon differs from all the known seed genera described from Nidpur plant beds in bearing characteristic apical snout. Further, it stands apart from *Rostrumaspermum* because of lack of archegonia in their megaspore sac. In the striking features of archegonia, *Rostrumaspermum* compares with detached petrified seeds mostly known from Palaeozoic sediments of northern hemisphere but the present taxon being compressed, obviously seed lacks vascular supply and the other anatomical details and thus it can be easily differentiated from all such seeds. The two taxa preserved as petrifactions, viz., *Aetheotesta elliptica* Renault 1896, and *Rhabdospermum tunicatum* Seward 1919, possessing radially disposed spaces and apical snout, have exhibited close identity with the genus *Rostrumaspermum* but in other characters, because of being in petrified state, these genera readily differ from *R. venkatachalae*.

The other petrified taxa, viz., *Lagenostoma ovoides, Pachytesta hexangulata, Cycadinocarpus angustodunensis, Cardiocarpus spinatus, Taxospermum undulatum*, markedly differ from *R. venkatachalae* in having two archegonia flanking a "tentpole" at the distal end.

The new genus also compares with the seed compressions: *Collospermum* and *Palaeocarpus* reported from Lower Gondwana (Karharbari Formation) of India (Pant *et al.*, 1985) in the presence of archegonia but *R. venkatachalae* distinguishes itself from the latter two genera in its tubular archegonia and distinctive apical snout. Also, the new genus lacks well-differentiated tentpole as has been exhibited in the aforesaid Permian seed-compressions.

Further, the occurrence of tubular archegonia in *R. venkatachalae* suggests that this seed might belong to plants which could be allied to Cordaitales or Ginkgoales. However, this possibility is remote because no fructifications referable to these groups have so far been recorded. Besides, in possessing short tubular archegonia *R. venkatachalae* is distinctive from *Ginkgo biloba* but in this feature the former comes closer to *Pinus laricio* and *P. sylvestris*.

Rostrumaspermum venkatachalae sp. nov.
Pl. 1, figs 1-9, Text-fig. 1A-N

Diagnosis—Seed ovate, platyspermic, outline entire, measuring 2-3 mm in length and 1.5-2 mm in breadth; chalazal end broadly rounded, tapering towards micropylar end having flattened apex; somewhat looking like apical snout; integument consisting of outer region tending to be thin along flanks and base, highly developed at apex, forming outer integument characterized by radially disposed spaces; structurally outer integument composed of irregular cells with their surfaces interspersed with pits of varying sizes, pits frequently occurring in hemispherical disposed spaces, entire integumentary cellular organization appearing to be contorted, integument closely abutted to nucellus but free at apex; nucellar membrane confluent to megaspore membrane, composed of thin-walled, elongated, rectangular-polygonal cells distinctly marked over the megaspore body; micropylar opening ± rounded, intensively cutinized depicting radially elongated cells; megaspore obscured in cellular details, dark-brown in colour occupying maximum space of nucellus, more or less forming an ovoid to ovate sac; at the micropylar end of megaspore sac two dark spherical bodies bearing tube-like neck considered as to be archegonium present; archegonia highly cutinized, cell outlines not discernible; between the two archegonia a cutinized mass superposed by one of the archegonia somewhat rounded flattened in structure distinctly marked and interpreted as to be immature archegonium.

Holotype—Slide no. BSIP 10270.

Locality—Nidpur, Sidhi District, Madhya Pradesh.

Age—Middle Triassic.

Remarks—Nucellar cuticle is mostly fused with the megaspore membrane and occasionally cellular markings or imprints are seen over megaspore body. At times, because of over maceration, seed-cuticles split into pieces and the two layers of megaspore sac become evident which is indicative of double nature of megaspore membrane. Other seed specimens belonging to *R. venkatachalae* have not shown the presence of archegonia but the pits have been commonly observed in the radially disposed spaces. Absence of archegonia may be due to the fact that the development of archegonia might have been deferred until female gametophyte is completely cellular (Foster & Gifford, 1974).

Comparison—In characteristic features of snout-like structure and occurrence of archegonia at the micropylar end the present taxon can be clearly differentiated from the other genera, viz. *Rugaspermum, Savitrispermum, Nidispermum, Pyriformispermum, Pantiaspermum* and *Rotundaspermum*, reported from Nidpur fossiliferous beds. Further, in the nature of integument these taxa generally possess tough

integument composed of varied cell shapes while in *R. venkatachalae* the outer integument is extremely thin and delicate having irregular-shaped cells.

Archegoniate seeds whether preserved as petrifaction or compression, markedly differ from *R. venkatachalae* in bearing distinct tentpole. Besides, these archegonia bearing seeds completely lack tubular neck and the archegonia can occasionally be located in sunken state towards the micropylar end. *Callospermarion undulatum* (Neely) Rothwell 1981 alone comes closer to archegoniate seeds of Nidpur in having tubular archegonia but the former at once contrasts from the latter because of being anatomically preserved form. In details of anatomy, the comparison between *R. venkatachalae* and *C. undulatum* is not possible because of the state of preservation. *Collospermum* and *Palaeocarpus* described by Pant *et al.* (1985) from Lower Gondwana of India also differ from *R. venkatachalae* in having archegonia without tubular neck.

Amongst the extant forms, in gymnosperms, there is a tendency of shortening of neck, and also archegonia are located in varied position. Conifers have been exception where archegonia show a lateral position; similarly *Ephedra* also shows laterally placed archegonia. But *Ephedra* stands apart from *R. venkatachalae* in having large neck. However, *R. venkatachalae* bears a tubular neck and in this particular character it comes closer to *Pinus laricio* and *Pinus sylvestris* (Foster & Gifford, 1974; Sporne, 1974) where the two archegonia are associated with a short tubular neck. Occasionally, in *P. sylvestris* varying number of archegonia have also been noticed.

In general organization of apical portion of megaspore sac, *R. venkatachalae* may be compared with *Ginkgo biloba* but in the latter, archegonia are quite distinctive because of rudimentary neck (Maheshwari & Sanwal, 1963). Also, in *G. biloba* the number of archegonia ranges from 2-4 while in the present new seed only two archegonia have been observed.

Affinity—The ongoing characteristics of the present taxon have led to the conclusion that its relationship is closer to Coniferophytes (Coniferales) than the other plant groups. The presence of archegonia with tubular neck settles its affiliations with the extant species, *Pinus laricio* and *P. sylvestris*. This resemblance is indicative of the occurrence of *Pinus*-like plants in Nidpur flora. This could be further substantiated by the findings of needle-like compressions from the same strata. However, this character is not suggestive that the family Pinaceae must have been originated during Triassic period. But certainly it can be inferred that such coniferous traits must have been differentiated during Triassic time because conifers were passing through transitional stage during Early Mesozoic (Bailey, 1933). Depiction of such pinéaceous features in Triassic seed supports the view of Meyen (1974) that separation of modern conifers took place at this stage.

The conspicuous absence of pollen chamber and free nucellus from integument at its apex sufficiently strengthens the evidence for its relationship with coniferales.

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