

## CHAPTER-32

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### A FOSSIL SEED FROM THE MAASTRICHTIAN-DANIAN DECCAN INTERTRAPPEAN SEQUENCES OF MARAI PATAN, MAHARASHTRA, INDIA

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#### Summary

A dicotyledonous fossil seed has been described from the newly explored locality Marai Patan of Vidarbha region of Maharashtra state, central India. The fossil seed is solidly silicified within the chert was recovered by breaking pieces of chert. From the reconstruction based on a slide by slide observation, it had been concluded that the petrified structures under consideration was a small sized ovate. Seed is orthotropous, dicotyledonous, unitegmic. Testa is undifferentiated, tegmen is single layered, sclerenchymatous compactly arranged, nuclear endosperm. Embryo is thin walled parenchymatous, embryo length is less than  $\frac{3}{4}$  of the seed length and width is about  $\frac{1}{4}$  of seed width. For assigning the fossil seed to proper family, it is compared with living genera of modern dicot families. The present report of a new seed of Piperaceae from newly explored locality Marai Patan is a noteworthy contribution to our knowledge of fossil seed.

**Keyword:** Fossil seed, Deccan Intertrappean, Piperaceae, Dicotyledonous, Maastrichtian-annian etc.

#### Introduction

Millions of years ago the face of the earth is rapidly changing into a more modern grab of vegetation. Central part of India must have noticed the long,

low, flat-topped hills which dominate the scenery over the greater part of country drained by the Narmada and Tapti and by the upper reaches of the Godavari and Krishna rivers. The number of places where such fossiliferous beds are exposed as out crop on the surface chiefly on the slopes of hills, Sometimes the farmer tills a patch of rocky soil and his plough turns up a boulder rich in fossil remains. The weathered surface reveals already to the naked eye the shells of mollusks, seeds and fruits, fragments of fossil stems, roots and leaves ; the interior holds promise of an unknown wealth of petrified life. A dicotyledonous fossil seed has been described from the newly explored locality Marai Patan of Vidarbha region of Maharashtra state, central India. (Fig.1) The reconstruction based on a slide by slide observation, it had been concluded that the petrified structures under consideration was a small sized ovate dicotyledonous seed.

Earlier Ramteke and Kapgate (2017) reported a fossil pteridophytic megasporocarp of *Salvinia* and infructants of *Viracarpus* fruits (2018) from this locality. Number of seeds have been reported from the different fossiliferous localities of the Deccan Intertrappean beds of India. Kumar (1984) reported fossil seed under the name *Clusiocarpus deccanii* from the Intertrappean beds of India. *Clusiocarpus indicum* was reported by Kolhe and Wazalwar (1998) from the same beds. *Ramakonospermus chitaleyensis* Matin *et al.*, (2009), *Mahabaleyspermum minutum* and *Deccanosperma arillata* are the seeds reported by Juneja (1993) from the Intertrappean beds of India. Shiekh and Bhowal (2003) reported fossil seed under the name *Ramakonospermus singapurii* from Singhpur beds of MP, India. *Unonaspermum corneri* (Bonde, 1993), *Cappariocarpus nagpurii* (Konde and Kolhe, 2012). *Sabniospermum trapii* (Pundkar, 2017). In addition to these, some workers have studies seeds of already reported fruits i.e. *Viracarpus hexaspermum* (Chitaley, 1958) and structure of embryo in the seeds of *Enigmocarpus parijai* Sahni (Biradar and Mahabale, 1974), *Phoenixoid* seed (Ambawani and Dutta, 2005). Numbers of fruits with seeds, both dicotyledonous and monocotyledonous are reported from the Intertrappean beds of India. But the report of isolated seeds is very rare. Hence the present report of a new seed of Piperaceae from newly explored locality Marai Patan is a new record and noteworthy contribution to our knowledge of fossil seed.

## Materials and Methods

The seeds are preserved in chert from the Deccan Intertrappean beds exposed in a quarry near the village of Marai Patan of Vidarbha region, India about 80 km from Chandrapur at N 21° 13.280', E 79°0.84'. Isolated mature seeds was found at this site. The period of Deccan volcanism bracketed the Cretaceous-Tertiary boundary, and is considered to have extended over about years (ca. 65 mya; chronos 30N–29N; Hooper *et al.*, 2010).

The fossil seed is solidly silicified within the chert was recovered by breaking pieces of chert with hammers and successive peels were taken from the broken surface, prepared by the butyl acetate liquid application peel technique following etching in hydrofluoric acid as described in Kapgate *et al.*, (2011). Peels were

archived on glass slides with coverslips mounted using D.P.X. mountant (HiMedia Laboratories Pvt. Ltd., Mumbai, India). Anatomical images were taken with the Sony Pix HD camera mounted on a compound research microscope.

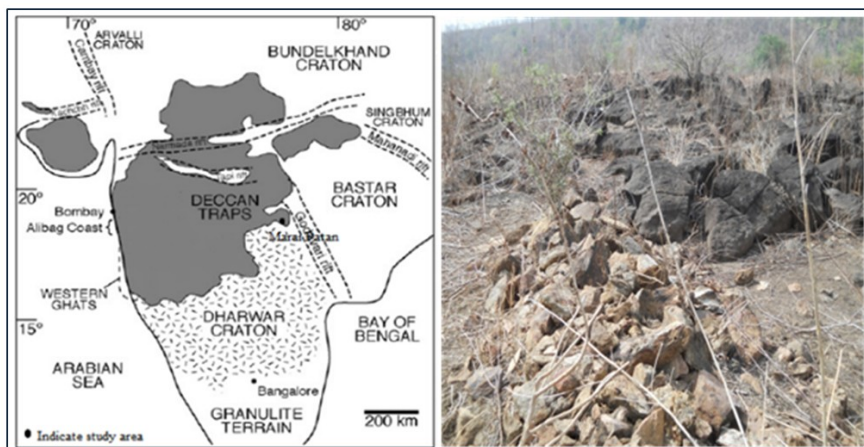


**Fig 1:** Map of Deccan trap of central India and fossil locality.

### *Description*

While breaking the collected black chert, a specimen of seed is exposed in longitudinal plane. Seed is ellipsoidal and differentiated into seed coat and large embryo. The detailed description of each part of the seed is given below as seed morphology, seed-coat, testa, tegmen, seed cavity, embryo and endosperm.

**Seed Morphology-** Seed small, ovate, Spindle shaped or fusiform broad at the middle and tapering at both the ends (Plate 1, fig.1, Text fig.1), orthotropous, dicotyledonous, unitegmic having hypocotyl at one end measured 140  $\mu\text{m}$  in length and 230  $\mu\text{m}$  in width. The width of the seed at the micropylar end was 130  $\mu\text{m}$  (Plate 1, fig.5, Text fig.5); and 100  $\mu\text{m}$  at chalazal end (Plate 1, fig.2). Vasculature could not be seen preserved. Exostome and chalazal end at the same plane indicating orthotropous position.

**Seed Coat-** The exotesta is compressed. The seed coat is unitegmic and not well differentiated into testa and tegmen. Seed coat is thin showing differentiation hardly into two layers. Thus present specimen shows the characters resembling with the unitegmic seed. The seed coat is measuring about 133  $\mu\text{m}$  in thickness. The outer layer of seed coat is very thin it might be testa. This layer is followed by tegmen.

**Testa-** Testa is made up of single layer of cells which is undifferentiated. It showed variation in thickness 5-6  $\mu\text{m}$  thick (Plate 1, fig.3, Text fig.2).

**Tegmen-** It is single layered, sclerified and thick walled measuring 35-47  $\mu\text{m}$  in thickness (Plate 1, fig.3, Text fig.2). At the micropylar end it appears to be ruptured (Plate 1, fig.5, Text fig.5). Sclerenchymatous cells are compactly arranged without intercellular spaces. They are rectangular in shape and

measured 20-30  $\mu\text{m}$ . The gap is observed between testa and tegmen. The gap is measures about 32-40  $\mu\text{m}$  in thickness.

**Seed Cavity-** A gap is observed between the tegmen and the embryo showing nuclear endosperm. The area occupied by the endosperm is 30-31  $\mu\text{m}$  at the tapering ends and 12-20  $\mu\text{m}$  at the broader region. The seed coat encloses an oval seed cavity containing an embryo.

**Embryo -** Embryo appears to be made up of thin walled cells with single layer epidermis. Embryo is large in size occupies maximum space of the seed cavity. In between wall of the embryo, there is a narrow space all around (Plate 1, fig.1, Text fig.1). However some thin walled parenchymatous cells are still preserved in this nucellar region. The wall of embryo is made up of thin parenchymatous cells which are irregular in shape. Embryo length is less than  $\frac{3}{4}$  of the seed length. And width is about  $\frac{1}{4}$  of seed width. Few circular embryonic cells are preserved at chalazal end (Plate 1, fig.6, Text fig.4). Embryo seen preserved and measures 0.91 mm-1.92 mm. Cells of embryo measures 30  $\mu\text{m}$  in diameter. At broadest part embryo measured 0.91mm in thickness. Hypocotyl region is differentiated into radical at outside and plumule at inside of the seed cavity (Plate 1, fig.4, Text fig.3). Hypocotyl region was about 140  $\mu\text{m}$  in length and 230  $\mu\text{m}$  wide. Few cells in hypocotyl can be seen which were hexagonal measured about 10-25 $\mu\text{m}$  in dimensions. Cells of Radicle are 15-25  $\mu\text{m}$  in size. Wall of embryo is 7-20  $\mu\text{m}$  in thickness.

**Nucellus-** Around the embryo, a narrow empty space is seen which represents the nucellus. Nucellar tissue is preserved at some places and is parenchymatous.

**Endosperm -** Remnants of endospermous tissue were seen at chalazal as well as mycophylar end. It measured 30-110  $\mu\text{m}$  in thickness.

## Discussion and Identification

For assigning the fossil seed to proper family, it is compared with living genera of modern dicot families. The available literature was thoroughly searched for the anatomical and embryological characters: Goebel (1905), Rendle (1971), Maheshwari (1950), Hutchinson (1959), Porter (1959), Esau (1970), Fahn (1974), Metcalfe (1960), Metcalfe and Chalk (1950) and most useful of all, by Corner (1976).

### *Comparison with modern taxa-*

As the present fossil specimen is described as dicotyledonous, unitegmic seeds it can be compared with the dicotyledonous living families having unitegmic seeds. Out of some 350 families of Dicotyledons, about 105 families appear to have only unitegmic ovules, which are sympetalous in nature and considered as more advanced than the polypetalous or the apetalous (Comer, 1976). Comer (1976) has mentioned 105 families having unitegmic seeds we have considered here some families having orthotropous ovules, ellipsoidal seed and embryo fills the seed which are Burseraceae, Fagaceae, Monimiaceae, Salicaceae, Rosaceae, Piperaceae and Rafflesiaceae, Anacardiaceae, Balsaminaceae, Halorrhagaceae, Icadinaceae and Ochnaceae. In Balsaminaceae, Halorrhagaceae, Icadinaceae and

Ochnaceae families two vesitigeal integuments are present i.e. two integuments adjoin the nucellus and chalaza while persist at micropylar end of the seed. As such condition is not observed in present fossil seed cannot be compared with these families having pachychalazal seeds.

In families Burseraceae, Fagaceae, Monimiaceae and Salicaceae it seems to be the inner integument disappears to form unitegmic seed (Corner, 1976). In Burseraceae, Fagaceae and Monimiaceae the seeds are unitegmic but the seed coat consists of testa and tegmen. The testa evidently multiplicative with thin walled, tangentially elongated cells. While the tegmen layer of seed coat in all these families gets soon or eventually crushed. So only one integument is involved in the formation of seed coat. Thus present fossil specimen does not resemble to the above mentioned families as it is exotegmic in nature.

When seed of Rosaceae is compared with present fossil seed it shows some similarities but differs from it not in having the seed without endosperm and with either integument disappears or both integuments connect to make a pachychalazal seed. When present fossil seed is compared with the seed of Rafflesiaceae, it differs in not having minute seeds measuring 0.5 to 1 mm long and inner layer of tegmen is crushed. In some species testa as a single layer of pulpy cells which is not seen in present specimen. In Anacardiaceae seed are medium to large in size with integuments often crushed and tegmen often persistent. In this family protective function of seed coat is generally carried by endocarp. It differs from present seed in having large size embryo and occupying whole seed cavity. This is considered as more advanced among the forest families (Comer, 1976). When present fossil seed is compared with the seed of Piperaceae it shares most of the characters, including size of seeds in this family ranging from 1-6 mm long, ovoid, exarillate, seed coats not multiplicative. Testa soon crushed without trace. Tegmen is distinct at the micropylar end similar to present fossil seed. Thus showing close resemblance with it.

#### ***Comparison with known fossil seeds-***

The present fossil seed is compared with the earlier reported fossil seeds. The previously described seed *Clusiocarpus arillatus* (Kumar, 1984) is compared with present fossil seed differs in having aril. When compared with the *Ramakonaspermus chitaleyensis* (Juneja, 1993) present fossil seed shows dissimilarities in not having bitegmic and mesotestal seed, embryo in the former is curved and convolute which is straight in present specimen. *Deccanasperma arillata* (Juneja, 1993) also differs from the present fossil seed in having arillate and bitegmic characters of the seed.

When present fossil specimen is compared with *Clusiocarpus indicum* (Wazalwar, 1990) it differs in having seed coat differentiation into testa and tegmen i.e. bitegmic which is not seen in the described seed.

In *Unonasperrum corneri* (Bonde, 1993) seed is elongated, ellipsoidal and bitegmic. The seed is characterised by having ruminated seed coat. All above mentioned characters are not observed in present fossil seed so it is different. Ambwani and Debi Dutta (2005) have of Arecaceae from of dinosaurian

coprolite at Pisdura, in Maharashtra. The seed is ovoid in shape, endosperm cells are compact seems to be ruminated. This monocot seed cannot be compared with the present fossil seed as later is dicotyledonous. This is the record of unitegmic seed from the Deccan Intertrappean Beds of Mohgaonkalan. *Ramakonospermus chitaleyensis* Matin *et al.*, (2009) differs in anatropous seed, ex-albuminous, seed coat bitegmic, testa multiplicative. When compared with *Cappariocarpous nagpurii* (Konde and Kolhe, 2012) it differs in having campylotropous ovule, curved embryo and bitegmic seed coat. As it is different from all other previously described seeds in its structure and also do not totally resemble with the seeds of any species of living families. But shows some similarities with the seed structure of family Piperaceae. Thus the seed can be assigned to the Piperaceae family but needs further investigation. It is named as *Chitaleospermum patanii* gen et sp. nov. The generic name is after the eminent palaeobotanist Dr. S. D. Chitley and specific name is given after the locality Patan.

## Results and Conclusion

The main object of this work is to contribute information regarding the fossil flora during 65 millions years ago belonging Deccan Intertrappean beds of central India. To establish relationship of plant evolution and environmental changes during upper Cretaceous period and different fossil localities of central India. Presence of fossils of family Piperaceae indicates the presence of a much uniform warm humid tropical climate in central India during the late cretaceous to early tertiary period.

## DIAGNOSIS

### *Chitaleospermum gen nov.*

Orthotropous, dicotyledonous, unitegmic seed, Testa is undifferentiated, Tegmenis single layered, sclerenchymatous compactly arranged, nuclear endosperm, Embryo thin walled parenchymatous, embryo length is less than  $\frac{3}{4}$  of the seed length and width is about  $\frac{1}{4}$  of seed width.

### *Chitaleospermum patanii gen. et sp. nov.*

Small, oval, orthotropous, dicotyledonous, unitegmic seed measuring 2.43 mm in length and 1.25 mm in width. Seed coat differentiated into Testa and Tegmen measuring about 133  $\mu$ m in thickness. Testa is single celled, undifferentiated, 5-6  $\mu$ m in thickness. Tegmenis single layered, compactly arranged sclerenchymatous cells measuring 20-30  $\mu$ m in thickness. The gap is observed between testa and tegmen measures about 32-40  $\mu$ m in thickness. Nuclear endosperm is 30-31  $\mu$ m at the tapering ends and 12-20  $\mu$ m at the broader region. Embryo is thin walled, parenchymatous, single celled, large in size measuring 0.91 mm-1.92 mm in length and 30  $\mu$ m in diameter. Embryo length is less than  $\frac{3}{4}$  of the seed length and width is about  $\frac{1}{4}$  of seed width. Hypocotyl region is differentiated into radical at outside and plumule at inside of the seed cavity. Hypocotyl region was about 140  $\mu$ m in length and 230  $\mu$ m width. Cells of radicle are 15-25  $\mu$ m in size.

Wall of the embryo is 7 -20  $\mu\text{m}$  in thickness. All the features described above made it possible to assign it to a family of its close resemblance. On the basis of the seed coat characters it appears that the seed belonged to the dicotyledonous family. Exostome and chalazal end at the same plane indicating orthotropous position.

**Holotype:** - DDR/Seed/Deposited at Deccan Flora museum and Palaeobotanical Research laboratory, Sakoli, India.

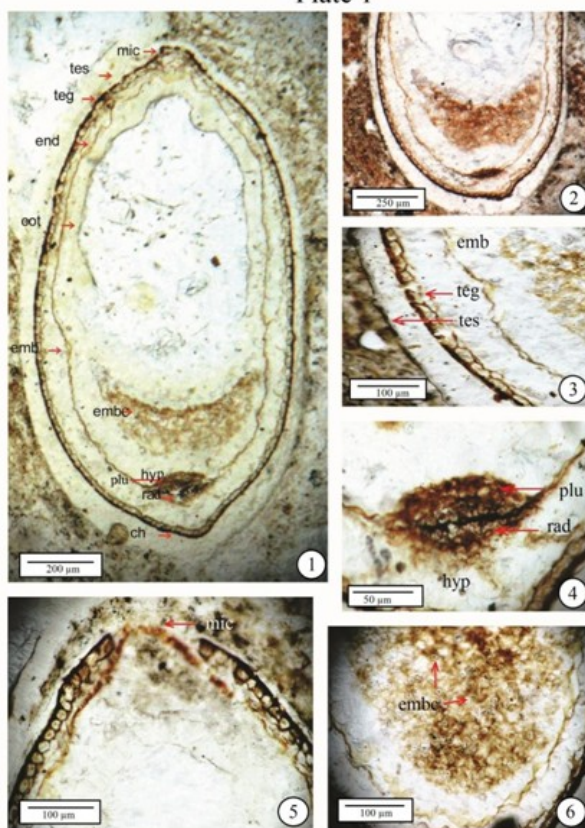
**Horizon:** - Deccan Intertrappean Series of India.

**Locality:** - Marai Patan, (M.S.) India.

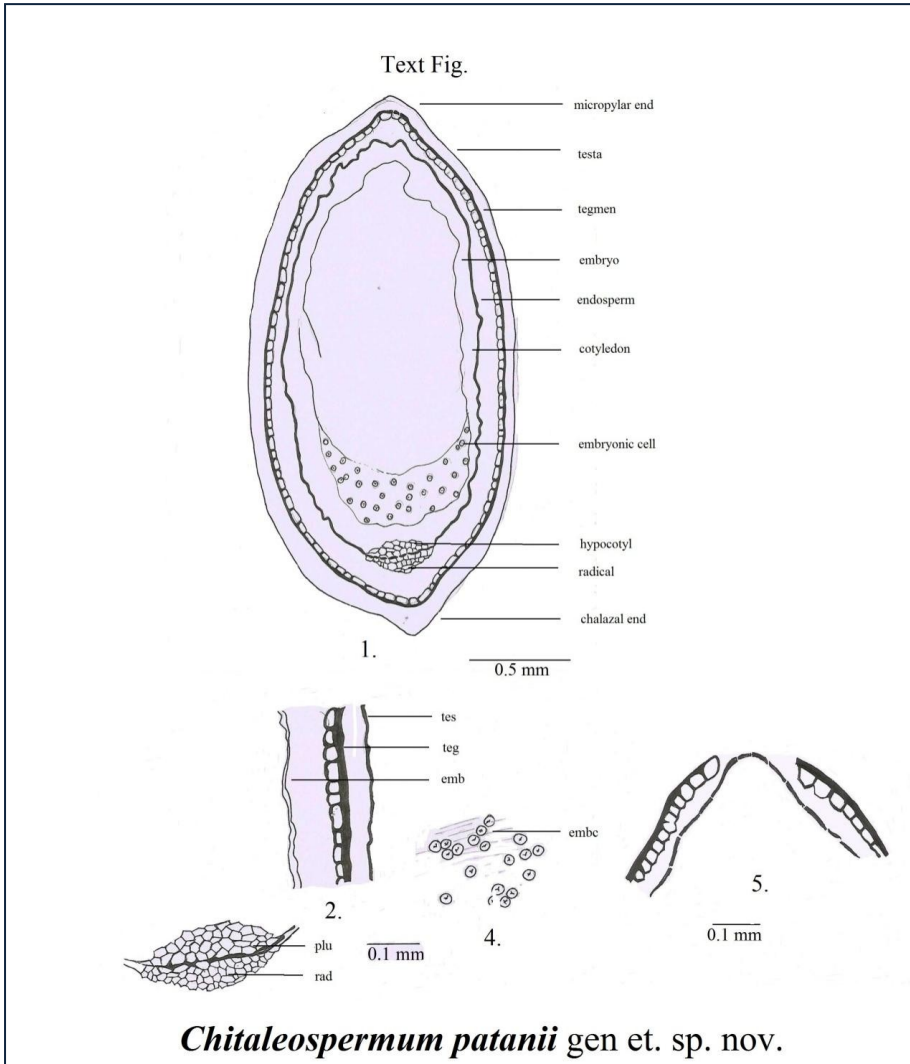
**Age:** - Maastrichtian-Danian.

*Chitaleospermum patanii* gen et. sp. nov.

Plate 1



*Chitaleospermum patanii* gen et. sp. nov.



**Explanation of Plate 1**

- i. Longitudinal section of the specimen showing anatomical details arrow indicates micropylar end (mic), testa (tes), tegmen (teg), endosperm (end), cotyledon (cot), embryo (emb), embryonic cells (embc), hypocotyls (hyp), plumule (plu), radical (rad) and chalazal end (ch) x 20.
- ii. L.S. of seed showing chalazal end with hypocotyls and embryonic cells x 20.

- iii. L.S. of seed showing seed coat, testa (tes) and tegmen (teg) x 40.
- iv. L.S. of seed showing hypocotyls (hyp) with radical (rad) and plumule (plu) x 40.
- v. L.S. of seed showing micropylar end (mic) x 40.
- vi. L.S. of seed showing embryonic cells (embc) x 40.

### ***Explanation of Text figures 1 to 5***

- i. Diagrammatic sketch of complete seed in L.S.
- ii. Diagrammatic sketch of seed showing testa (tes), tegmen (teg) and embryo (emb).
- iii. Diagrammatic sketch of seed showing hypocotyls region with plumul (plu) and radical (rad).
- iv. Diagrammatic sketch of seed showing embryonic cells (embc).
- v. Diagrammatic sketch of seed showing micropylar end of seed.

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