

Report of *Equisetites sahnii* gen. et sp. nov. A Pteridophytic strobilus from the Late Cretaceous Beds of Singpur Madhya Pradesh, India

¹ SU Borkar, ² VD Nagrale, ³ AN Korpenwar, ⁴ DD Ramteke

^{1,2} Department of Botany, Institute of Science, Nagpur, Maharashtra, India

³ Department of Botany, Rashtrapita Mahatma Gandhi College, Nagbhir, Chandrapur, Maharashtra, India

⁴ Department of Botany, J.M. Patel College, Bhandara, Amravati, Maharashtra, India

Abstract

Equisetum is a small and morphologically distinct genus of 15 extant species that are the sole surviving representatives of the class Sphenopsida with a rich fossil record. The permineralized pteridophytic strobilus cut in tranverse plane of Equisetaceae was collected from the late cretaceous cherts of Singpur, Madhya Pradesh, India. The serial peel sections were taken through its exposed plane and shows excellent preservation with cellular details and taken for study. Present strobilus is bilaterally symmetrical of about 1.8 mm X 1 mm in size with thick and multi-layered sporangial wall of approximately 100 µm. It shows six chambers of sporangia containing few microspores. Microspores are in a group containing 7 to 15 microspores. It is spherical, 20-40 µm in diameter. Microspore wall with two layers, a relatively smooth, dark inner layer and much thicker spongy layer outside it. A distinct triradiate mark observed from apical surface of microspore. As it show close similarities with family Equisetaceae, it is kept under the genus *Equisetum* and named as *Equisetites sahnii* gen. et sp. nov.

Keywords: Peemineralized, strobilus, microspores, *Equisetites sahnii* etc

1. Introduction

Equisetum is a small and morphologically distinct genus of 15 extant species that are the sole surviving representatives of the class Sphenopsida with a rich fossil record. According to the fossil record, primitive forms possibly assignable to Sphenopsida appeared in the late Devonian [1]. Sphenopsida then reached maximum diversity during the Carboniferous. Afterwards, major extinction episodes took place during the early Permian and the Late Jurassic. Since the beginning of the Cenozoic, all known Sphenopsida have been herbaceous forms that are indistinguishable from living horsetails [2]. Fossils attributed to the genus *Equisetites* that closely resemble modern *Equisetum* date from the Permian [2] and possibly even from the Carboniferous [1]. On account of the similarity between *Equisetites* fossils and living *Equisetum* species, the distinction made between these two genera has been questioned to the point that Arnold [3] proposed that *Equisetum* might be regarded as the oldest surviving vascular plant genus in the world. *Equisetum* is a small, easily recognized, and highly distinctive genus of vascular plants with a subcosmopolitan distribution [4].

This paper describes permineralized pteridophytic strobilus of Equisetales collected from the Deccan Intertrappean beds of locality Singpur, Madhya Pradesh, India. (Figure-1) So far few pteridophytic sporocarp is reported from the Deccan

Intertrappean beds of central India like *Regnellidium rodeites* [5]; *Azolla sporocarp* [6], *Massulites coelatus* [5]; *Rodeites dakshinii* [5, 7], *Rodeites polycarpa* [8], *Rodeites dakshini ver. intertrappeana* [9], *Rodeites sahnii* [9, 10]; *Salvinia intertrappea* [6,7,9, 10, 11], *Surangea mohgaonse* [13], *Prakashites mohgaonse* [10], *Kuprianovites deccanii* [12] Whereas the present pteridophytic fossil material is reported is a new finding and added to the knowledge of singpur flora.

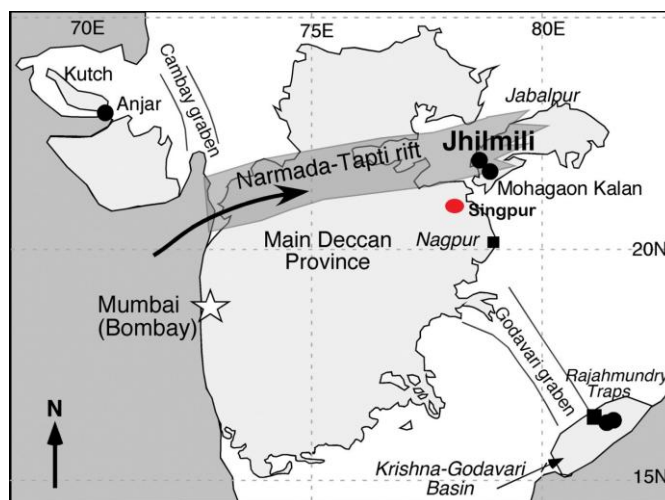


Fig 1: Western and central India showing extent of Deccan basalts, showing fossil locality Singpur.

2. Material and Methods

The material was exposed on a black silicified chert had been collected from the uppermost cretaceous Deccan Intertrappean sedimentary beds of Singpur, Madhya Pradesh, India during the field visit. The collected specimen subjected to etching with hydrofluoric acid and thoroughly washed under water. The material is very small but with careful observation by using hand lens, it appears elongated to elliptical body which cut in oblique transverse plane. Then serial peel sections were taken through its exposed plane with cellulose acetate peel technique. The slides were prepared by mounting the peels in DPX as a mount and photographed the slide after observing under research microscope. It show excellent preservation with cellular details and taken for study.

3. Description

Present specimen from a piece of Deccan Intertrappean chert of Singpur, shows pteridophytic strobilus cut in oblique transverse plane with microsporangia and spores. On closer

study it has been found to be the strobilus of *Equisetales*, which includes following parts-

- **Strobilus:** It is bilaterally symmetrical, elliptical to elongate in shape of about 1.8 mm X 1 mm in size (Pl.1, Fig.1). The stalk of strobilus is preserved at one side. It has six sporangia. Few microspores are preserved in only 4 sporangia (Pl.1, Fig.4).
- Presence of thick centrally placed hexagonal axis (Pl.2, Fig.4). Central axis bears a peltate appendage called the sporangiophore. Central axis protrudes out 6 stalks it means 6 sporangiophore may be attached to the central axis. Peltate appendage is seen on a single pair of sporangia (Pl.1, Fig. 2, 3).
- **Stalk of sporangiophore:** A stalk is appears from central axis of strobilus. It is composed of thin walled parenchymatous cells. Stalk measures 110 µm broad toward the central axis and 20 µm at the terminal end (Pl.1, Fig.2).
- **Sporangia:** 6 sporangium is observed on the exposed chert. Out of these sporangia 1 pair is attached to the peltate disc and central axis. Each sporangium is elongated, sac like and rounded at the apex. It measures about 300 µm X 550 µm in size (Pl.2, Fig.1, 2)
- **Sporangium wall:** Sporangium wall is very thick approximately 100 µm, multi-layered. Innermost layer is single celled, parenchymatous measures 20 µm in thickness (Pl.2, Fig.3).
- **Spores:** The sporangium contains spherical microspores in a bunch of about 7 to 15 in numbers; few are in solitary (Pl.1, Fig.5). It is spherical about 20-40 µm in diameter. Microspore shows a distinct triradiated mark from apical surface view (Pl.2, Fig.1, 2). The spore preserved two layers: a relatively smooth, dark inner layer 1.5 µm thick and much thicker 2 µm spongy looking layer outside it.

4. Discussion and Identification

The above described specimen revealed following important details for its identification.

- Strobilus is bilaterally symmetrical, elliptical to elongate in shape.
- Unisporangiate type i.e. microspores.
- Centrally placed hexagonal thick axis.
- Single whorl of sporangia bearing peltated appendage.
- Pair of sporangium is attached with the central axis.
- Sporangium is elongated, sac like and rounded at the apex.
- The sporangium contains 7 to 15 microspores in a bunch.
- Few solitary microspores are present.
- Microspore wall shows clearly preserved two layers, dark inner layer and much thicker spongy outer layer.
- Microspore shows a distinct triradiated mark.

From the above features the present described pteridophytic specimen indicates close affinity with the strobilus of *Equisetales* (Pl.2, Fig.5).

For identification of above described strobilus, it is compared with the living strobilus of Lycopodiaceae, Sellaginaceae, Equisetaceae, Marsiliaceae and Polypodiaceae family as well as reported fossil reproductive parts of pteridophytes from the Deccan Intertrappean beds of central India.

Comparison with the already known fossil pteridophytic reproductive part.

The present fossil material is compared with the already known fossil pteridophytic reproductive part. *Regnellidium rodeites* [5] differs in having heterospory and a member of Marsileaceae. *Massulites coelatus* [5] differs in microspore of salvinia consisted of small, hollow, spherical bodies of pseudo-cellular mass in which number of small rounded spores are embedded. *Surangea mohgaonse* [13] and *Prakashites mohgaonse* [10] differs in a member of Incertae sedis Filicales. *Rodeites polycarpa* [8] and *Rodeites dakshini ver. intertrappeana* [9] differs in heterospory and a member of Salviniaceae. *Salvinia intertrappea* [10, 11] differs in a member of Salviniaceae. *Rodeites sahnii* [8] differs in having numerous megaspores packed in a midst of microspores. *Azolla sporocarp* [6] differs in having heterospory a member of Salviniaceae. From this comparison it is clear that the present specimen does not show any similarities with the reported fossil pteridophytes.

Comparison with the modern taxa

The living genus of Lycopodiaceae considered for the comparison of this fossil strobilus is *Lycopodium*. It shows much variation like alternate arrangement of sterile and fertile region in the strobilus. In *Selaginella* of family Selaginaceae both micro and megaspores are present i.e. heterospory in nature. The living genera of Marsileaceae considered for the comparison of this fossil sporocarp is *Marsilea*. It shows difference in having heterospores, the bilateral nature of sporocarp. In *Dryopteris* of family Polypodiaceae differs in having the sporangia produced in kidney shaped sori situated on the leaves called sporophylls.

There is a great deal of resemblance of present strobilus and spores with those of the living genus *Equisetum* of family Equisetaceae. This fossil material resembles in having sporangia in the underside of peltate sporangiophore. Sporangium is elongated and sac like. Presence of thick axis. The sporangia contains microspores with triradiate mark, Homosporus. Presence of 6 stalks attached with the central axis.

As it show close similarities with equisetum cone it is named as *Equisetitis sahnii* gen. et sp. nov. The specific name after the eminent Palaeobotanist Dr. Birbal Sahnii.

5. Diagnosis

Equisetitis sahnii gen. nov

Bilaterally symmetrical, elliptical to elongated strobilus with very thick and multi-layered sporocarp wall. Hexagonal central axis bears 6 stalk of sporangiophore. Sporangium is elongated, sac like and rounded at the apex. Spherical microspores in a bunch of about 7 to 15 in number; few are in solitary. Unisporangiate type i.e. microspores. Microspore shows a distinct triradiated mark from apical surface view. A relatively smooth, dark inner layer 1.5 µm thick and 2 µm spongy looking layer outside it.

Equisetitis sahnii gen. et sp. nov

Bilaterally symmetrical, elliptical to elongate in shaped strobilus of about 1.8 mm X 1 mm in size with very thick and

multi-layered sporocarp wall approximately 100 μm . Hexagonal central axis bears 6 peltate appendage called the sporangiophore. Spherical microspores in a bunch of about 7 to 15 in number; few are in solitary. Microspore shows a distinct triradiated mark from apical surface view. A relatively smooth, dark inner layer 1.5 μm thick and 2 μm spongy looking layer outside it.

Holotype-VDN/Ang. Fruit/Deposited in Botany Department, Institute of Science, Nagpur

Horizon- Deccan Intertrappean Series of Madhya Pradesh.

Locality- Singhpur, Madhya Pradesh, India.

Age- Late Cretaceous-Palaeocene

Equisetitis sahnii gen. et sp. nov.

Explanation of Plate fig. 1

1. Oblique Transverse section showing complete strobilus (50x).
2. A pair of sporangia showing peltate appendage and stalk of sporangiophore (100x).
3. A pair of sporangia showing peltate appendage (100x).
4. Single sporangia with bunch of microspores (100x).
5. Magnified view of microspores (100x).

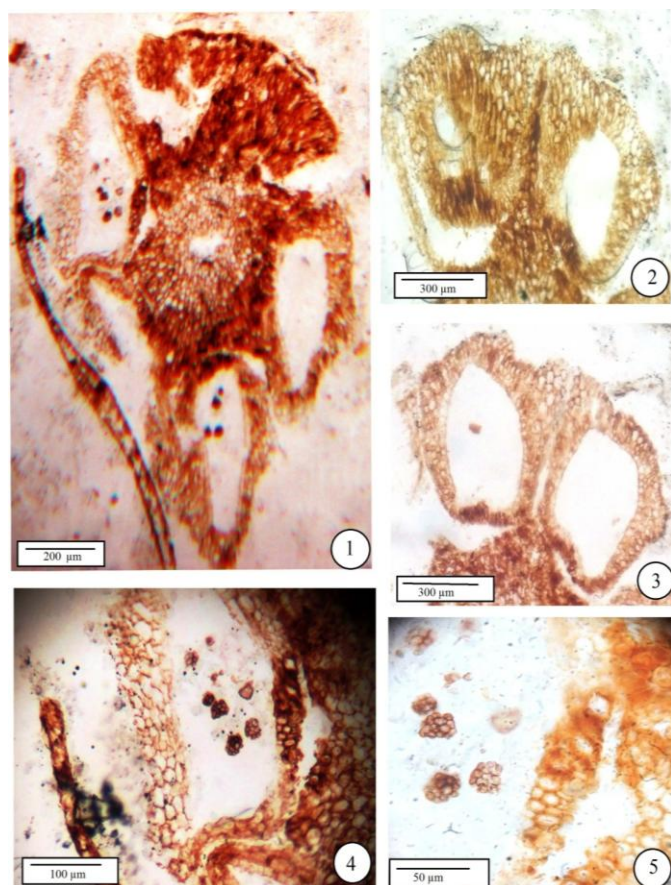


Fig 1: *Equisetitis sahnii* gen. et sp. nov.

Equisetitis sahnii gen. et sp. nov.

Explanation of Plate fig. 2

1. & 2. Magnified view of microspores (450x).
3. Magnified view of single sporangia showing wall of sporangium (450x).

4. Transverse section showing axis of strobilus (450x).
5. Transverse section of strobilus of extant member of equisetales (50x).
6. Transverse section of strobilus fossil specimen (50x).

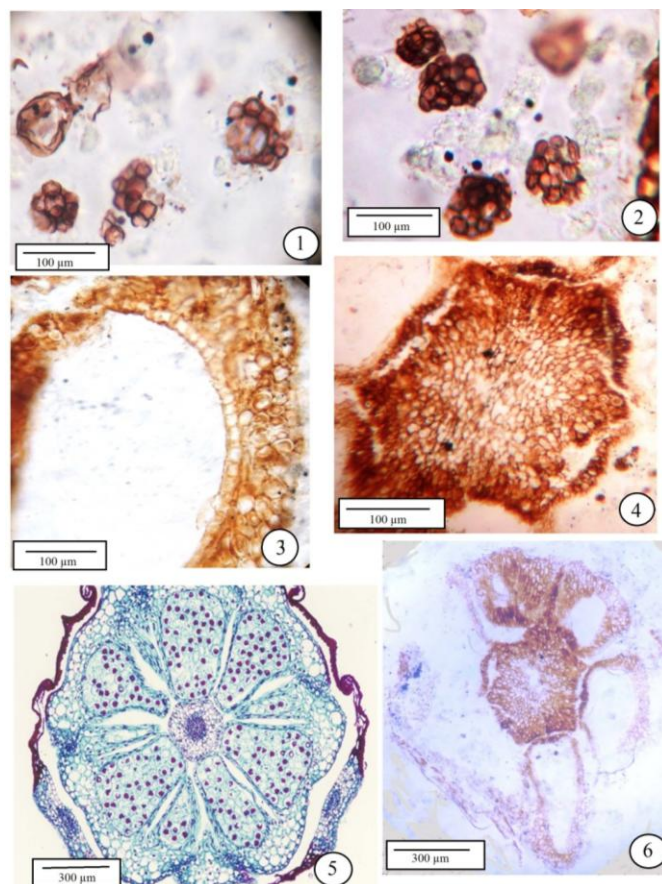


Fig 2: *Equisetitis sahnii* gen. et sp. nov

6. References

1. Taylor TN, Taylor EN. The biology and evolution of fossil plants. Prentice Hall, Englewood Cliffs, N.J., 1993.
2. Stewart WN, Rothwell GW. Paleobotany and the evolution of plants. Cambridge University Press, Cambridge, 1993.
3. Arnold CA. An introduction to paleobotany. McGraw-Hill, New York, 1947.
4. Kathleen MP, Des Marais DL, Smith AR, Britton DM. Phylogenetic relationships and evolution of extant horsetails, *equisetum*, based on chloroplast DNA sequence data (*rbcl* and *trnL-f*). International Journal of plant sciences. 2003; 164(5):737-751.
5. Sahn B, Rao HS. A silicified flora from the Deccan Intertrappean cherts round Sausar in the Deccan. Proceedings of National Academy of Sciences India. 1943; 13:36-75.
6. Nambudiri EMV, Chitale SD. Fossil *salvinia* and *Azolla* from the Deccan Intertrappean beds of India. Review of palaeobotany and Palynology. 1991; 69:325-336.
7. Mahabale TS. A species of fossil *Salvinia* from Deccan Intertrappean series, India. Nature, London. 1950; 65:400-411.

8. Chitale SD, Paradkar SA. *Rodeites* Sahni-Reinvestigated - I. *Palaeobotanist*, 1971; 20: 293-296.
9. Chitale SD, Paradkar SA. *Rodeites* Sahni-Reinvestigated-I. *Journal of Linn. Society London*. 1972; 65:109-117.
10. Chitale SD. Petrified Sporocarp of *Salviniaceae*. *Current Science*. 1977; 46:25.
11. Paradkar SA, Barlinge SG. *Salvinia intertrappea* Mahabale reinvestigated: in Bharadwaj D.C. *et al* (Editor) *Proc. 4th in Palynol.* Lucknow, 1976-77 I, Birbal Sahni Institute of Palaeobotany, Lucknow. 1979, PP. 494-499.
12. Nambudiri EMV, Thomas MK. *Kuprianovaites deccanii* gen. et sp. nov., a new petrified sporocarp from the Deccan Intertrappean beds of Mohgaon Kalan. *Journal of Palynology*. 1969; 5:51-52.
13. Chitale SD, Sheikh MT. *Surangea mohgaoense* gen. et sp. nov., a pteridophytic fructification from Deccan Intertrappean beds of India. *Geophytology*. 1971; I:123.