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# *Salvinia Sahanii* Sp. Nov. A Pteridophytic Sporocarp from Deccan Intertrappean Beds of Marai Patan, Maharashtra, India.

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**Abstract**
Plant fossil are usually fragments of separated part such as roots, stems, leaves, petioles, flowers, spores, fruits, seeds etc. In central India, these are chiefly found in Deccan Intertrappean beds. The present work completed through intensive study pteridophytic sporocarp *Salvinia sahanii* sp nov. is considered to be the megasporocarp from the Deccan Intertrappean beds of Marai Patan (N 19$^0$ 34.322; E 79$^0$08.402) of Chandrapur district (M.S.) was described in considerable detail.. The fossils were recovered by breaking pieces of chert Successive peels were taken from the broken surface. The sporocarp is isolated with small stalk and fertile leaf. The sporocarp contains five megaspores. Megaspores are oval to circular in shape. Megaspores have 14 to 17 vertical ridges in the perisporial wall. The specimen described here has now added to our knowledge about this plant species.
**Key Words:** Pteridophytic, Sporocarp, *Salvinia,* Megasporocarp, Deccan Intertrappean, etc

## INTRODUCTION

The Deccan Intertrappean beds in central India have yielded a diverse flora dominated by angiosperm woods, leaves, flowers and fruits. Fossils whose nearest living relatives are wetland plants are very abundant in the fossil record Sahni & Rao (1943), Chitaley (1977), Paradkar & Barlinge (1979), Nambudiri & Chitaley (1991). In many cases facies association and taphonomic considerations, as well as morphological features (e.g. aerenchyma heterophylly) and more rarely rooting in situ, conclusively demonstrate the wetland habitat of the ancient plants (e.g. Paradkar and Barlinge, 1977, 1979; Collinson, 1980). Because of their abundance these fossils have provided excellent examples of morphological change through time which have considerable potential for evolutionary and phylogenetic analyses. These wetland fossils are also significant for interpretation of ancient lacustrine, marsh and swamp communites and ecosystems, their spatial and temporal succession and evolution, and their response to global environmental change (Collinson 1980, Collinson & Hooker 2000).

Sahni *et al.* (1934) reported *Sausarospermum fermori* which, at that time, they considered to be a gymnospermous seed. Sahni and Rao (1943) subsequently described megaspores, massulae and vegetative remains of *Azolla intertrappea* and a new genus *Massullites coelatus.* Mahabale (1950) recognized that the two genera, *Sausarospermum* and *Massullites* resembled mega and micro-spores of extant *Salvinia.* Although Chitaley (1951) recognized five pteridophytic spore genera in palynomorph assemblage, pteridophytic macrofossils appear to be scarce in the lacustrine to estuarine cherts in Chhindwara district, Madhya Pradesh, India. Heterosporous sporocarps, described so far from the Deccan Intertrappeans are *Kuprianovaites deccanianus* (Nambudiri and Thomas, 1969), *Surangea mohgaoense* (Chitaley and Sheikh, 1971) and *Rodeites deccanianus* (Chitaley and Paradkar, 1971, 1972). Chitaley (1977) briefly reported new specimens of permineralized sporocarps resembling extant *Salvinia* and *Azolla* from the Deccan Intertrappean cherts of Mohgaon Kalan. Paradkar and Barlinge (1979) reported on the morphological details of the micro and megasporocarps of *Salvinia intertrappea*. *Salvinitis deccaniana* (Nambudiri & Chitaley, 1991) reported sporocarp with single megaspore.

Follow in account of *Salvinia sahanii* sp nov. sporocarp is considered to be the megasporocarp from the Deccan Intertrappean beds of Marai Patan (N 19$^0$ 34.322; E 79$^0$08.402) of Chandrapur district (M.S.) was described in considerable detail. The sporocarp is isolated with small stalk and fertile leaf. The sporocarp contain five megaspores. Megaspores are oval to circular in shape. Megaspores have 14 to 17 vertical ridges in the perisporial wall. The specimen described here has now added to our knowledge about this plant species.

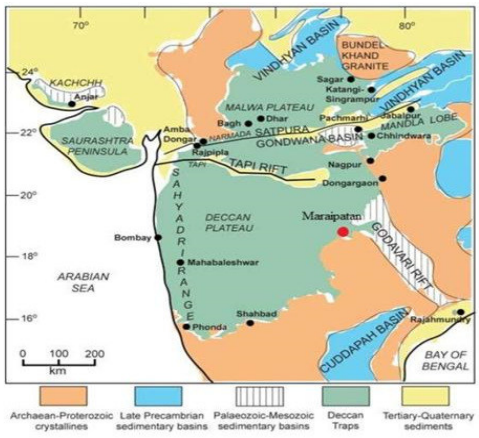



**Fig.: Modified map of central India showing locality of study site (in red color)**

## MATERIAL AND METHODS

The material is collected from the Field of the Marai Patan region of Chandrapur district, Maharashtra, India. The fossil material of leptosporangiate water fern were found in black cherts. After breaking and itching the chert with hydrofluoric acid, the specimen was exposed in longitudinal section. The specimen was exposed and observed by naked eyes. It appears triangular-round. On the piece of chert specimens of *Salvinia* were preserved. Several cellulose acetate peel sections were prepared from rock surface. Serial peel sections enabled anatomical and morphological studies of the specimen for better understanding of their structure.

## DESCRIPTION

The longitudinally exposed sporocarp is tetrahydral enclosing megaspores. Megaspore is triangular to circular, having three sides giving triangle like appearance (Pl.2 fig.4) to the spore and globose i.e. having circular outline (Pl.2 figs.1, 2). On closer study it has been found to be the trilete-perinous type of megaspore with 70-85 µm in polar diameter and 95-110 µm in equatorial diameter, having a peculiar frill of perisporium (Pl.2 fig.4). No vascular traces are observed in the section.

### Sporocarp

**Morphological features-** The sporocarp is isolated with small stalk and fertile leaf (Pl.1 fig.1). The oblong sporocarp is 2.1 mm long and 0.9 mm wide enclosing five megaspores (Pl.1 fig.2). Degraded material inside the megasporocarp (Pl.1 figs.4, 5) may represent sporo-genous tissue. The sporocarp wall is divided into an outer and an inner wall. The triangular to circular megaspore is 95-110 µm long and 70-85 µm wide. Multicellular thin walled stalk is present attached to sporocarp wall. The stalk is 0.3 x 0.5 mm in size.

**Anatomical features- Stalk:** The stalk has three layered cells. The outer layer is thin parenchymatous cells which is undifferentiated measuring 10-21 µm in thickness. The middle layer is composed of thick walled, squarish to hexagonal cells with dark contents. It has 4 to 8 cells in thickness measuring 11-19 µm in thickness. Few air spaces are present. The inner layer is composed of elongated, two to three cells in thickness measuring 8-15 µm in thickness. Below the inner layer of the stalk, big air cavity is present (Pl.2 fig.3).

The wall of sporocarp is two layered. The outer layer of the wall is composed of thick walled columnar cells. The inner layer is composed of thin walled cells (Pl.2 fig.6).

### Spore

In the megasporangia there are five megaspores unequal in size oval to eliptical indicating the developing stage. They are bigger in size. The diameter of each megaspore ranges from 70 to 110 µm. The shape of each spore is triangular to circular. Each spore is surrounded by three spore coats.

**Exospore:** It is outer, thick, hard, compact and uniform/homogeneous exosporial coat about 5µ thick (Pl.1 fig.3).

**Endospore:** It is the innermost layer, adjacent to the cell cytoplasm.

**Perispore:** It is outermost layer, also known as perisporium showing the spongy perisporial frill of 30 µm to 60 µm thickness, composed of much enlarged rectangular cells. It constitutes main part of the wall. Megaspores have 14 to 17 vertical ridges in the perisporial wall (Pl.2 fig.4). A distinct gap is seen in between the perisporium and the exospores indicating the presence of parenchymatous tissues. A distinct oval to triangular foot is observed in each megaspore. The cell structure of foot is not clear (Pl.2 fig. 5).

**DISCUSSION AND IDENTIFICATION**

For assigning the fossil pteridophytic sporocarp, it is compared with living genera of modern species of *Salvinia*. The available literature was thoroughly searched for the anatomical and morphological characters.

From the above description following important features are confirmed:

- Present megaspore is large sized.
- Triangular, having three sides giving triangle like appearance and globose i.e. having circular outline.
- There are peculiar frill of perisporium present with 14 to 17 vertical ridges.
- No vascular traces are seen.
- The spore wall shows distinct three layers: the intine (endospore), the exine (exospores), and the perine (perispore).
- Foot in the perisporial wall.

From the above features the pteridophytic specimen confirmed as megaspore of *Salvinia*.

For identification present specimen of above described megaspore, it is compared with living as well as reported fossil *Salvinia* from the Deccan Intertrappean beds of India.

**Comparison with modern species**

It is compared with the sporocarps and isolated megaspores of following modern *Salvinia* species. Such as *Salvinian atanus* Hoffm., *Salvinia cucullata* Roxb., *Salvinia intertrappea* and *Salvinia auriculata* Aub. Comparison with modern species of *Salvinia* leaves no doubt regarding similarities with the sporocarp described in this paper. At the same time, several differences in the structure of the sporocarp are noticed. One of the major differences between the present fossil species and species of modern *Salvinia* is in the organization of the sporocarp wall. In extant species the sporocarp wall is formed of a single layer of cells which initially develops as an indusium (Eames, 1936). In our material however, the sporocarp wall is divided into two distinct layers, each of them several cells thick. The perispore is formed of a mass of rectangular tissues. The presence of a well defined foot observed in the megaspore of the present specimen is rather puzzling. In extant species of *Salvinia* once the spores are liberated from the sporocarp, they rise to the water surface and fertilization takes place. Eames (1936) reported that a foot which develops after fertilization, functions as a haustorium. The foot in extant species, like in present fossil material, quite enlarged. The megaspore enclosed by the perisporium wall with a foot, suggesting that fertilization occurs, in present specimen, while the megaspore is still within the sporocarp tissue. An intrasporic embryo as reported here and in other fossil *Salvinia* was considered by Paradkar and Barlinge (1984) as a most evolved feature. From the above discussion it is interesting to note that this fossil megaspore is closely related to, but certainly not identical with *Salvinia auriculata* and *Salvinia intertrappea*.

**Comparison with reported fossil species**

The present megaspore is compared with following reported fossil *Salvinia* spores:-

*Sausarospermum fermori* (Sahni *et al.*, 1934) differs in having small, oval, elliptical, seed like bodies, each having peculiar frill about it, and two coating in the midst. At the apex there is a beak like projection. *Massulites* (Sahni & Rao, 1943) differs in having small, hollow, spherical bodies of pseudo-cellular mass in which number of small rounded spore are embedded. *Salvinia intertrappea* (Mahabale, 1950) investigates on living three *Salvinia* species, Mahabale comes on the conclusion that *Sausarospermum* is the megaspore and *Massulites* is the microspore of the fossil species, named as *Salvinia intertrappea*. The perispore is separated from the megaspore by a layer of rectangular cells. The beak reported by Sahni *et al.*, (1934) and Mahabale (1950) is lacking in present spores. Comparison with their material suggests several differences between their material and *Salvinitis patanii*. Main differences are found in the number of megaspores, layers of megaspore wall (two in present specimen and single layered in theirs) and the presence of prothallial tissue observed by Paradkar and Barlinge (1979), which is absent in present specimen. *Salvinitis deccaniana* (Nambudiri & Chitaley, 1991) shows similarities in ovate sporocarp, sporocarp wall, thick perispore with wavy outline but differs in having ovate sporocarps enclosing a single megaspore, megaspore attached to the perispore by a triangular foot, several hairy outgrowths are attached to the outer wall of the sporocarp.

Considering the above differences between present material and other extant and fossil ones, the present specimen warrants a new species name as *Salvinitis sahanii* sp. nov.

**DIAGNOSIS**

***Salvinia sahanii*** sp. nov.

A triangular, subglobose, trilete-perinous type of megaspore with 70-85 µm in polar diameter and 95-110 µm in equatorial diameter with highly vacuolized frill of perisporium about spore wall which showing distinct three layers: intine (endospore), innermost layer exine (exospores) compact homogeneous coat about 5 µ thick, and the perine (perispore) outermost, main part of the wall, showing the spongy perisporial frill of 30 µm to 60 µm thickness. No vascular traces. Foot oval to triangular

**Palaeovegetational and Palaeoenvironmental implications**

The influence of Deccan volcanic activity on contemporary biotas has been a matter of intense debate and controversy ever since it was suggested that the volcanic eruptions may represent a major Cretaceous-Tertiary boundry event and may have given rise to geochemical anomalies in transitional sequence. The plant fossil assemblage was recovered in association with a variety of plants from the Deccan Interrrappean beds of India. Regarding palaeogeography and palaeoclimate, this biota belonging to marine, estuarine, fresh water, marshy and terrestrial habitats with a warm tropical climate with heavy rain fall, a long duration of rainy season. The temperature was uniform throughout the year in the Deccan trap country as against a comparatively dry, subtropical climate at the present time. Presence of such a humid climate may be indicated to the almost equatorial position of peninsular India and seashore conditions during this period.

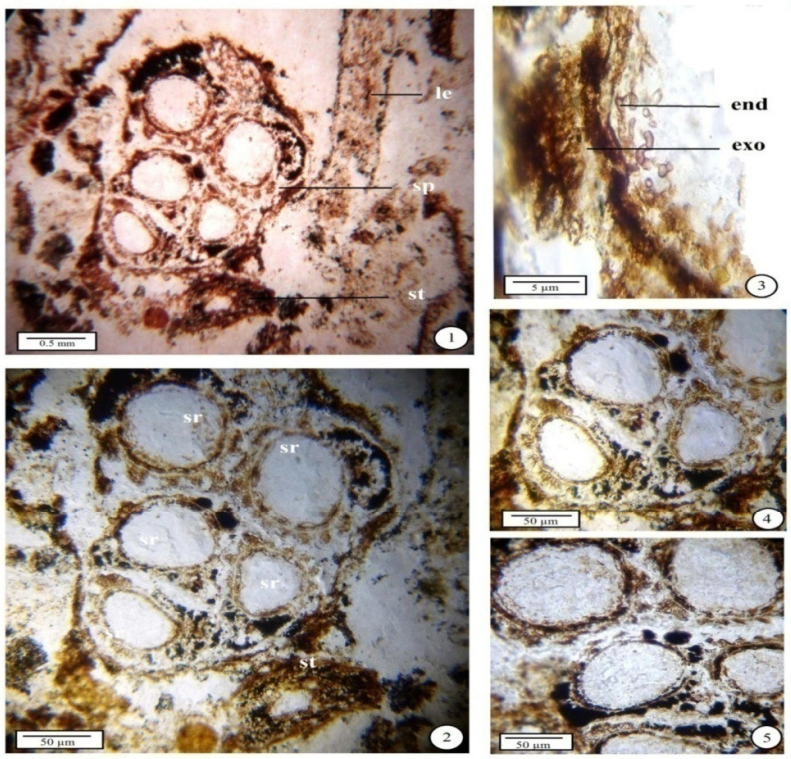
**Holotype: -** DDR/Pterido./Deposited at Dept. of Botany, J. M. Patel College,Bhandara.

**Horizon: -** Deccan Intertrappean Series.

**Locality: -** Maraipatan, Maharashtra.

**Age: -** Late Cretaceous (Maastritchian)-Palaeogene

Plate Fig. 1




**Salvinia sahanii** sp. nov.

**Explanation of Plate figure 1.**

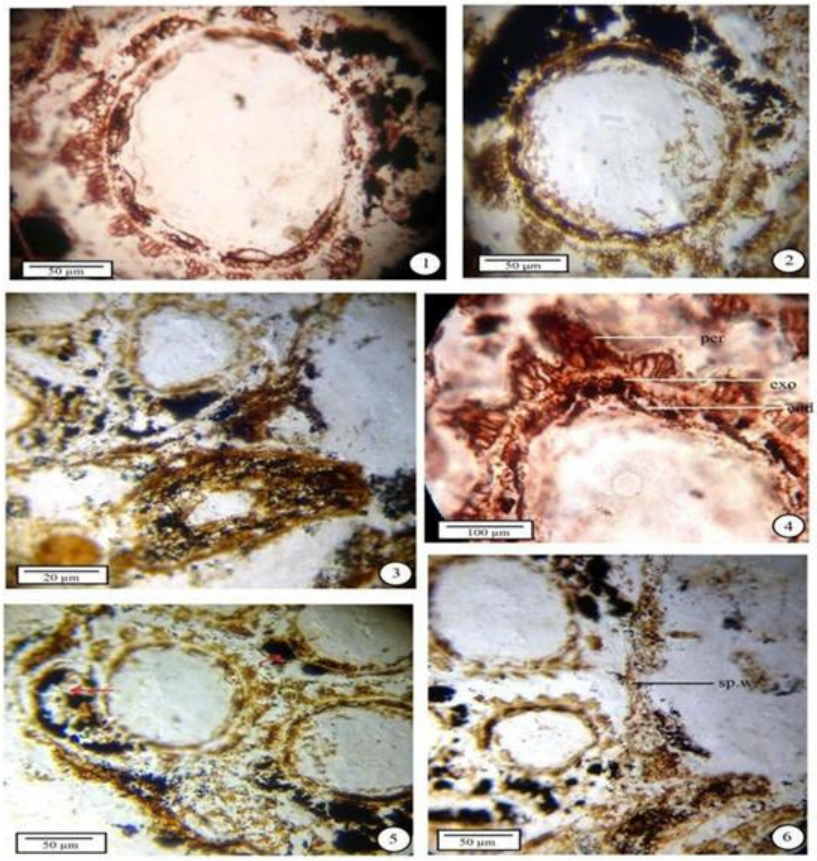
1.: Specimen exposed on fossiliferous chert with sporocarp and fertile leaf (20x). Fertile leaf (le), sporocarp (sp) and stalk (st).

2.: Enlarged view of a sporocarp enclosing five megaspores (50x). megaspore (sr), stalk (st)

3.: Magnified view of megaspore wall (100x). Endospore (end), exospores (exo)

4 & 5.: Megaspores showing different shapes and frill of perisporium (50x).

Plate Fig. 2




**Salvinia sahanii sp. nov.**

**Explanation of Plate figure 2**

1 & 2.: Megaspore showing oval shape of spore, frill of perisporium with furrows (50x).

3. Enlarged view of stalk (50x).

4. Triangular shaped megaspore showing frill of perisporium (per), exospores (exo) and endospore (end) (50x).

5. Enlarged view of sporocarp showing megaspores and foot (indicating with arrows) (50x).

6. Enlarged view of sporocarp showing sporocarp wall (sp.w.) (50x).

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