

SHUKLANITES DECCANII SINGHAI, AN ANTHOCEROTACEOUS SPOROGONIUM FROM THE DECCAN INTERTRAPPEAN BEDS OF MOHGAONKALAN*

L. C. SINGHAI

Asstt. Professor of Botany, Govt. Degree College, Jagdalpur

ABSTRACT

The present paper describes in detail bryophytic sporogonium *Shuklanites deccanii* Singhai (1964) from the Deccan Intertrappean beds of Mohgaonkalan. The sporogonium is pear-shaped, possibly embedded in the thalloid tissue and comprises a capsule and the bulbous foot. The capsule, devoid of columella, is full of spores and pseudoelaters. The affinities have been traced to both Anthocerotopsida and Hepaticopsida, though most of its characters are referable to the former group.

INTRODUCTION

OUR knowledge of fossil bryophytic sporogonia from India is meagre.

The types described include *Capsulites gondwanensis* Saksena (1958) from the South Rewa, and *Notothylas* type of sporogonium by Gupta (1956) from the Deccan Intertrappean beds of Mohgaonkalan. A brief note on this new genus *Shuklanites deccanii* from the Deccan Intertrappean beds of Mohgaonkalan was published by the author in 1964. In the present paper a fuller account of this form has been given.

The material described here was discovered in black chert piece from Mohgaonkalan locality of the Deccan Intertrappean Series. The present study of the sporogonium is based on successive peels taken out from a chert piece. The peels were examined both, under direct and reflected light and a detailed study of its structure was possible. Staining of the peel sections was also tried but it hardly proved useful in revealing the finer details.

DESCRIPTION

The sporogonium is a pear-shaped body measuring 1.5×0.75 mm in the longitudinal section inclusive of the foot (Pl. 1, fig. 2; Text-fig. 1). It consists of a capsule with a bulbous foot (Pl. 1, figs. 1-3; Text-fig. 1);

seta may be represented by a constriction (Pl. 1, fig. 2; Text-fig. 1). It is broader at the apical region than towards the base (Pl. 1, figs. 1 & 2; Text-fig. 1). The outer tissue of the capsule is parenchymatous, dark coloured forming lobed outgrowths; two of these situated laterally at the apical region are larger than others (Pl. 1, figs. 1-3). The cells of the surrounding tissue of the sporogonium and those of the foot are short and parenchymatous (Pl. 1, figs. 1-4).

Foot

The length of the foot ranges from 0.2 to 0.33 mm. The cells of the upper portion of the foot are comparatively longer and thicker walled (Pl. 1, fig. 2). These may be considered as the conducting cells of the sporogonium or cells of the meristematic zone as in Anthocerotales. This later view is ruled out considering the extremely mature nature of the sporogonium full of mature spores and pseudoelaters. The remaining cells of the foot are comparatively thinner walled (Pl. 1, fig. 2).

Just below the foot there are 2 or 3 outgrowths (Pl. 1, figs. 2 & 3) which might have been responsible for drawing food supply from the thallus. Pl. 1, figs. 2 and 3 show these processes practically in organic connection with a dorsiventral tissue lying close, possibly the vegetative thallus of the plant. The cells of this tissue are also parenchymatous, very much similar to those of the foot.

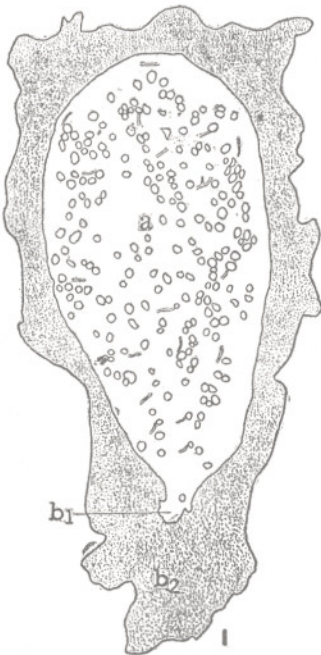
Pl. 1, fig. 1 shows the section passing obliquely through the sporogonium, just skipping the foot. It is represented by a sort of poorly preserved cavity in continuation with that of the capsule. In other successive peels, however, this cavity is not seen (Pl. 1, figs. 2 & 3; Text-figs. 1 & 2).

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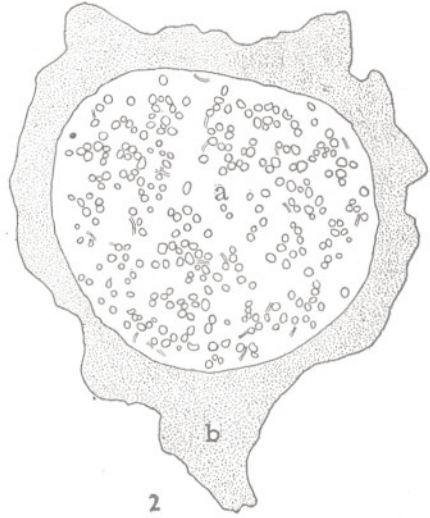
The tissue of the sporogonium wall is one with that of the foot. It is variously thickened being 2 to 6 layers in thickness (Pl. 1, figs. 1-3) measuring 0.05 mm to 0.14 mm. The cells of this tissue are similar to that of the foot though smaller.

Capsule

The capsule is pear-shaped (Pl. 1, fig. 2; Text-fig. 1) measuring 1.1×0.55 mm. The cavity of the capsule is full of spores and pseudoelaters (Pl. 1, figs. 1-3; Text-figs. 1 & 2), the former being profusely abundant while the latter sparsely distributed amongst them and congregated on all the sides of the capsular cavity. In the basal region both of these are quite scanty (Pl. 1, figs. 1-3; Text-figs. 1 & 2). The spores and pseudoelaters are again thinly distributed into the central region of the capsule (Pl. 1, figs. 2 & 3). Columella is absent. There also occur some patches of sterile tissue in the cavity, distributed rather unevenly (Pl. 1, fig. 1). These may be the remnants



TEXT-FIG. 1—*S. deccanii*. Radial Section of the sporogonium with the capsular region (a) full of spores and elaters, and a small upper empty region at the foot (b_1) and the remaining cellular region below (b_2) ($\times 62$).



TEXT-FIG. 2—*S. deccanii*. An almost transverse section of the sporogonium full of spores and pseudoelaters with capsular region (a) and the foot region slightly skipped (b) ($\times 58$).

of the sporogenous tissue which served as nourishment for the developing spores.

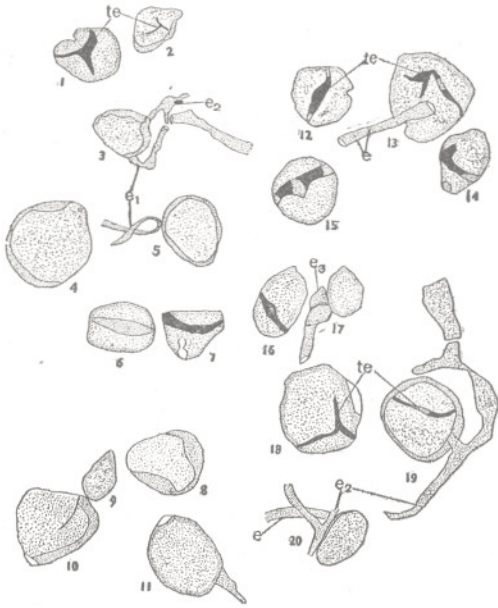
The wall of the capsule is 1 to 3 layers in thickness and devoid of stomata (Pl. 1, figs. 2-4). Its cells are mostly elongated and barrel shaped (Pl. 1, figs. 2 & 3). They are 2 to 3 layers thick at the apical region and usually one layer thick on all the other sides.

Spores

The spores are thin-walled, smooth, more or less transparent, yellowish in colour, round, oval, elliptical or triangular (Pl. 1, figs. 5 & 6; Text-fig. 3). These varying forms may be due to compression in petrification. Several spores also show a distinct triradiate mark (Pl. 1, fig. 5; Text-fig. 3 (1, 13 & 18) and at places definite tetrads are seen as well (Pl. 1, fig. 5). Both the inner and the outer walls of the spore are thin, the latter being comparatively thicker (Pl. 1, figs. 5 & 6). Certain spores show indication of germ pore (Pl. 1, figs. 7 & 8). On an average the spores measure 0.011×0.009 mm.

Pseudoelaters

The pseudoelaters are usually unicellular, thin-walled, more or less transparent, short, simple or occasionally branched (Pl. 1,



TEXT-FIG. 3—*S. deccanii*. Spores and Pseudoelaters (e) from the capsule. Spores 2 to 5, 8, 10 and 19 show the outer and the inner wall; 1, 2, 7, 12 to 16, 18 and 19 show either partial or complete triadate (te) mark. Pseudoelaters showing simple (e_1), branched (e_2) or septate (e_3) condition ($\times 1136$).

figs. 5, 8 & 9; Text-fig. 3e, e_1 & e_2). Spiral thickenings are absent; septate pseudoelaters also present occasionally (Pl. 1, fig. 9; Text-fig. 3 e_3). Line of dehiscence of the sporogonium not seen.

AFFINITIES

Comparison with the Living Forms — The present specimen shows affinities with Anthocerotales on the basis of the following distinguishing characters, viz., (1) the sporogonium consisting of only capsule and foot; (2) a well developed bulbous foot; (3) pseudoelaters simple; occasionally branched; (4) absence of columella as in some species of *Notothylas*, like *N. levieri*; (5) presence of rhizoidal outgrowths from the superficial cell's of the foot as in *Notothylas indica*; (6) seta as a constriction and (7) simple anatomy of the thallus (Campbell, 1928; Kashyap, 1929; Proskauer, 1948a, b, 1957; Pandey, 1932).

This specimen also shows resemblances with Sphaerocarpaceles in its simple thallus without air-chambers (*Sphaerocarpos*); ab-

sence of columella and ridged investment in the sporogonium as in *Riella*. But in the Sphaerocarpaceles seta is present and pseudoelaters or elaters are absent which easily differentiates it from the present specimen (Campbell, 1928; Cavers, 1911, pp. 3 to 11; Proskauer, 1954).

The present specimen, further, resembles Jungermanniales in its small, simple, and smooth spores but the absence of seta and the presence of pseudoelaters in the fossil distinctly differentiates it from Jungermanniales (Kashyap, 1929; Pandey & Srivastava, 1958; Srivastava, 1960; Parihar, 1965).

Thus, this specimen can only be referred to Anthocerotales on the basis of its important characters. A close comparison with the various genera of the Anthocerotales has been made.

Of the genera *Anthoceros*, *Phaeoceros*, *Notothylas*, *Dendroceros*, *Megaceros* (Proskauer, 1948, 1957) and *Folioceros* (Bharadwaj, 1971), comprising Anthocerotales, *Dendroceros* and *Megaceros* are distinct in possessing well marked spiral thickenings on their elaters, a feature absent in the present specimen, which in contrast possesses simple pseudoelaters.

Similarly, the genus *Anthoceros* differs from the present specimen in possessing a columella and epidermal stomata on the capsule, though it also possesses simple or branched pseudoelaters and bulbous foot.

The genus *Phaeoceros* also agrees with the present specimen in having a well developed foot, simple or branched pseudoelaters and yellow spores. However, it differs markedly in possessing a columella and epidermal stomata on the capsule wall.

The new genus *Folioceros* (Bharadwaj, 1971) also differs from the present fossil in having thickened bands, at places, beaded elaters and also the spores which are ornamented.

The genus *Notothylas* resembles the fossil in the possession of unicellular and short elaters; in the absence of columella as in *N. levieri* and *N. Chaudhurii* and in the absence of stomata on the capsular wall. However, it differs in having short, curved thickened bands (rudimentary spirals) on the wall of its elaters. *Notothylas breutellii* resembles our fossil specimen in the size of the capsule and the absence of columella (Lang, 1907) but differs from it in the

presence of a columella at the base in certain specimens, larger and dark spores with convex outer face studded with short, blunt almost black projections and elaters having yellowish brown thickenings in the form of more or less complete rings in contrast to thin-walled, smooth, more or less transparent spores and simple or branched elaters without any thickenings in the present specimen.

According to Lang (1907), Kashyap (1919, 1929), Goebel (1930), Bartlett (1928), Church (1919), Evans (1939) and Pandey (1934) the genus *Notothylas* is reduced and the species which have no columella represent the last stage in the reduction series. Accordingly this non-columellate fossil form must be regarded as reduced.

The present fossil in its simple anatomy of the thallus shows resemblance with Anthocerotales and Sphaerocarpaceae. It also shows resemblance with Sphaerocarpaceae in the absence of columella and the ridged investment over the sporogonium as in *Riella*. Besides, sporogonium also shows resemblance in its small, simple and smooth spores to certain members of Jungeimanniales like *Aneura*, *Riccardia* (Kashyap, 1929; Kashyap & Pandey, 1922-23; Pandey & Srivastava, 1958; Srivastava, 1960; Parihar, 1965; Watson, 1964).

Thus, it is remarkable that the present fossil shows close resemblance with Anthocerotopsida (Anthocerotae) on the one hand and also with Hepaticopsida (Hepaticae) on the other. Pandey (1934, p. 216) suggested that species like *Notothylas levieri*, form a connecting link between the Anthocerotales and other liverworts and further states "this fact suggests a close relationship between the two groups and favours the retention of the Anthocerotales within the Hepaticae". Campbell (1925) also suggested that the sporophyte of *Notothylas* shows a nearest approach to the sporophyte of other liverworts, but he does not think that the relationship is anything but a very remote one. The non-columellate condition, absence of mode of liberation of spores, simple anatomy of the thallus, simple, small and smooth spores and ridged investment over the sporogonium in the present specimen provides an additional possible link between Anthocerotopsida (Anthocerotae) and Hepaticopsida (Hepaticae).

According to Watson (1964) "early fossils which can be brought into line with Antho-

cerotales are quite unknown. Indeed, on the whole subject of the early history of sporophytes the fossil record is almost completely silent; and no hint has been forthcoming as to how the peculiar liverwort pattern of structure, with elaters playing a decisive role came into being".

Comparison with the fossil form — The specimen described by Gupta (1956) from the same locality under the designation "Bryophytic sporogonium" differs from our specimen not only in size and shape but also in the absence of distinct spores and elaters. Moreover, the present specimen is characterized by the possession of a bulbous foot.

GENERIC DIAGNOSIS

Shuklanites Singhai, 1964

Sporogonium pear-shaped with a bulbous foot, possibly embedded in the surrounding ridged tissue; seta as a constriction. *Capsule* pear shaped, broad at the apex and comparatively narrower at the base, profusely full of spores and pseudoelaters, columella absent; wall 1 to 3 layers; stomata absent. *Spores* simple, small, smooth, thin-walled, round, oval, elliptical or triangular with a distinct triradiate mark. *Pseudoelaters* thin-walled, usually unicellular, sometimes septate, simple or occasionally branched. *Foot* in the apical region representing the probable conductive region; and in the basal region possessing outgrowths. *Thallus* simple.

Genotype — *Shuklanites deccanii* Singhai, 1964

SPECIFIC DIAGNOSIS

Shuklanites deccanii Singhai, 1964

Sporogonium pear-shaped, broader at the apical region and comparatively narrower towards the base, measuring 1.50 × 0.75 mm. *Foot* bulbous, 0.2 to 0.33 mm in length. *Capsule* pear-shaped full of spores and pseudoelaters, measuring 1.1 × 0.55 mm. *Spores* simple, small, smooth, 0.011 × 0.009 mm. *Pseudoelaters* simple, occasionally branched, sometimes septate, 0.01 to 0.04 mm in length and 0.0022 mm in width.

Holotype — Specimen No. 30M in author's collection.

Horizon — Deccan Intertrappean Series.

Locality—Mohgaonkalan, Chhindwara district, Madhya Pradesh.

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EXPLANATION OF PLATES

Shuklanites deccanii Singhai, 1964

PLATE 1

1. *Shuklanites deccanii*. Almost radial section. The constriction marks the capsular region above (a) and the foot region below with an empty central zone (b) ($\times 67$).

2. The next section in series with exclusive capsular region (a) and the basal cellular region representing the foot (b) ($\times 74$).

3. The next section in the series showing probable organic connection of the sporogonium with the thalloid tissue (th) ($\times 52$).

4. A part of the capsular wall (w) and the peripheral thalloid tissue (th) ($\times 174$).

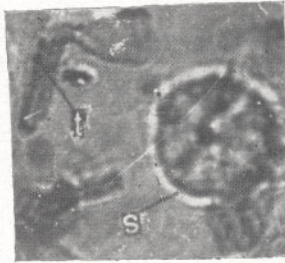
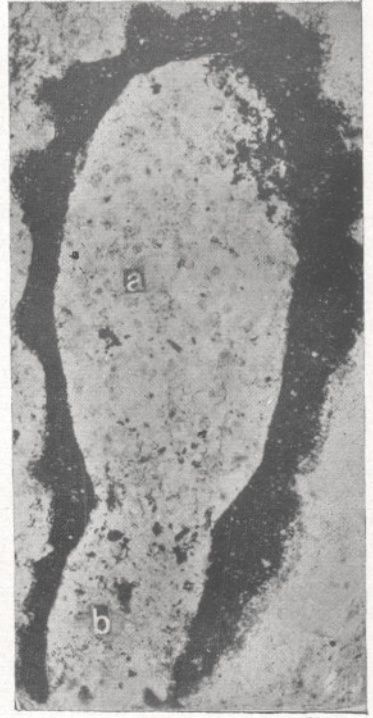
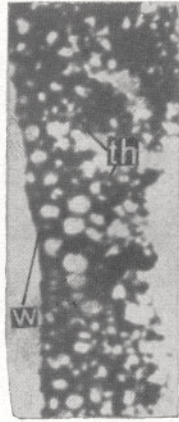
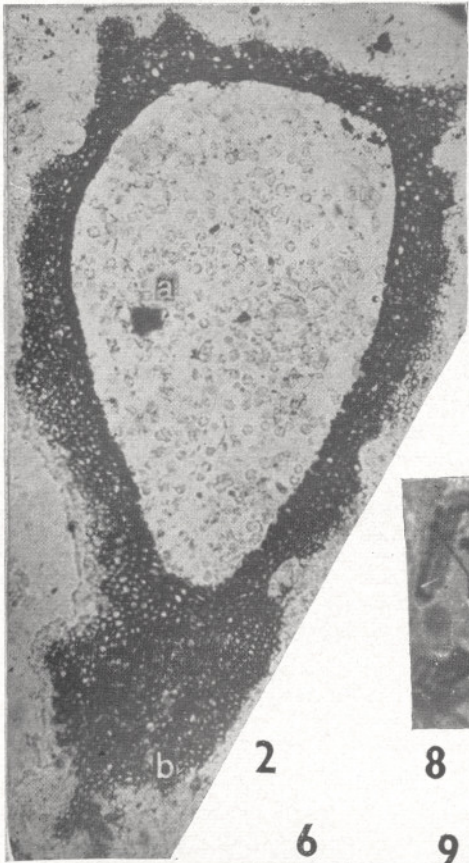
5. A portion of the sporogonium showing spores (s) with triradiate mark and pseudoelaters (e) ($\times 1273$).

6. Spores magnified to show the outer wall (ow) and the inner wall (iw) ($\times 1727$).

7. A spore showing germination (g) ($\times 722$).

8. A spore (s) and a septate pseudoelater (t) ($\times 1455$).

9. Two pseudoelaters. One of the pseudoelaters is branched (br) ($\times 1180$).



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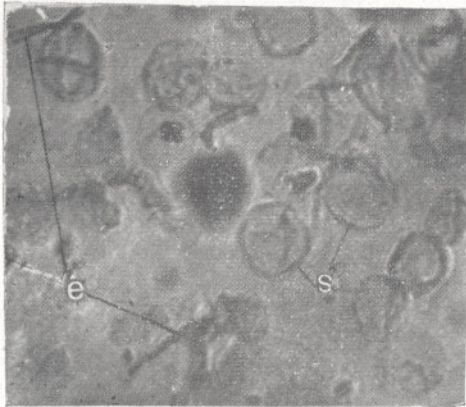
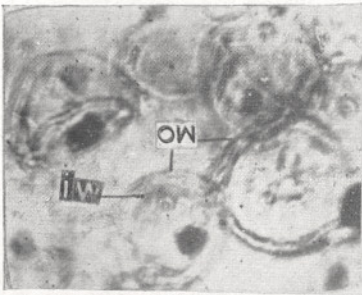
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