

# FURTHER OBSERVATIONS ON A PETRIFIED OVULIFEROUS CONE (*MOHGAOSTROBUS SAHNII* GEN. ET SP. NOV.) FROM MOHGAON CHERTS IN THE DECCAN

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## INTRODUCTION

RECENTLY I collected a small, broken specimen of a female cone from Mohgaon Kalan, which, on further examination, revealed to be identical with the one already described incompletely by me (1956). This specimen represents the basal part of a cone attached to a small stalk. The cone-axis is also present here.

The specimen which I described in 1956 showed only a part of a cone on one side of the cone-axis, cut in a tangential plane. Because of its incomplete nature some of the characters such as size and shape of the cone, structure of the cone-axis, single or double structure of the cone-scales could not be ascertained and hence no definite conclusion regarding its systematic position could be drawn. The present find helps to form a more complete picture of the female cone revealing all its important anatomical details. The following description is, therefore, based on both of these small specimens.

Both the silicified specimens were embedded in a rock matrix of black and red colour. Because of the small and fragmentary nature of the cones, their structure was followed through by gradual grinding and serial sketching at regular intervals. A number of peel sections were also prepared. At several instances photographs of the cone were also taken in reflected light. A few sections, both in cross and longitudinal planes, were prepared for anatomical study.

## DESCRIPTION

The present description of the cone is based on two small broken specimens. One of them is a tangential longitudinal part of a cone (PL. 1, FIG. 1), about 8 mm. thick and 2.5 cm. long which has already been described (PRAKASH, 1956). The other, representing the basal part of the cone, is a

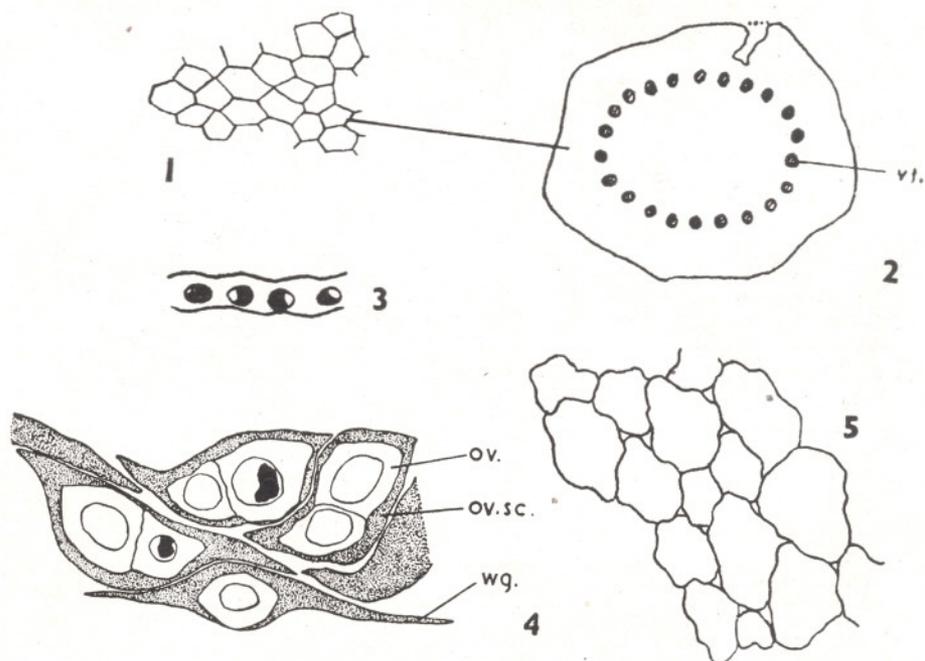
semi-circular piece with a cone-axis (PL. 1, FIGS. 2, 6) and attached to a short stalk. Here the cone is 16 mm. long and shows a radius of 10.5 mm. As the cone is only known in parts and remains slightly incomplete, it is not possible to give the exact shape and size of the cone.

*Peduncle* — Only 14 mm. long and 1.2-1.5 mm. in diameter (PL. 1, FIGS. 2, 6). It does not show any structures due to poor preservation.

*Cone-axis* — 2-2.5 mm. in diameter, not showing satisfactory preservation (PL. 1, FIG. 10). In cross-section it is bluntly angular in shape and shows a number of irregular cavities all over due to bad preservation (PL. 1, FIG. 10). The only tissue which is well preserved is towards the periphery, consisting of thin-walled, polygonal cells (TEXT-FIG. 1). The axis also shows, though indistinctly, a ring of vascular strands which are about twenty-two in number and in a state of poor preservation (TEXT-FIG. 2). The epidermal layer which is only preserved at one or two places, consists of slightly thick-walled cells filled with brownish gummy deposits (TEXT-FIG. 3). These cells are very much like the epidermal cells of the scales.

*Cone-scales* — Measuring 8.9.5 × 4.5.5 mm. in size are borne closely and spirally on the cone-axis (PL. 1, FIG. 1).

The scales have a long and nearly horizontal limb which expands distally and then turns upward to form a short upturned tip. Proximally the scales taper towards their junction with the cone-axis (PL. 1, FIGS. 4, 7, 10). They are thick in their middle region and expanded horizontally with their margins thinning out into wings which overlap those of the neighbouring scales (PL. 1, FIG. 1; TEXT-FIG. 4). Because of the fragmentary nature of the material, it was difficult to prepare desired sections in the longitudinal planes of the cone to ascertain the single or double structure of the cone-scales. How-



TEXT-FIGS. 1-5 — 1, Peripheral cells of the cone-axis.  $\times 630$ . 2, Cone-axis to show a ring of vascular strands (*vt.*).  $\times 16$ . 3, Cells of the epidermal layer of cone-axis.  $\times 180$ . 4, Some ovuliferous scales (*ov. sc.*) in cross-section showing embedded ovules (*ov.*). *wg.*-wing.  $\times 6.5$ . [This figure had also appeared in my earlier paper (1956, TEXT-FIG. 1)]. 5, Cells of ovuliferous scale.  $\times 315$ .

ever, from serial grinding and sketching which could mostly be done in the tangential plane of the cone-scales, it has been possible to know that the scales do not appear to possess a separate bract and an ovuliferous scale. The preservation of the present cone does not permit me to say anything more as to the morphology of its cone-scales. The scales have usually two ovules embedded in them but those at the apex are sterile (PL. 1, FIG. 1). Two scales in the middle region of the cone also seem to be sterile (PRAKASH, 1956, PL. 1, FIG. 3).

The scales do not show satisfactory preservation. They are composed of thin-walled cells (TEXT-FIG. 5) and show numerous small cavities which are abundant and prominent in the wings of the scales and in their distal part (PL. 1, FIGS. 4, 5, 7). However, they are scarce in the proximal part and mostly unrepresented in the region where the ovules are embedded. The nature of these cavities could not be definitely ascertained due to the lack of good and sufficient material; although they may be resin ducts.

The thick-walled cells reported previously by the author in some parts of the scales

could not be detected in the present which is only a slightly better preserved material. Probably they were due to the presence of dots of dark brown substance in the tissue of the scales, thus giving a wrong impression.

The epidermis of the scale is composed of slightly thick-walled, often somewhat globular, cells with their lumina usually filled with a black or brown gummy substance. The epidermis is sometimes loosely attached to the tissue of the scales (PL. 1, FIG. 5), presumably owing to the state of preservation.

*Ovules* — There are normally two cylindrical ovules embedded in each ovuliferous scale (PL. 1, FIG. 1). The ovules are about 3.5-5 mm. in length and 1-1.5 mm. in diameter. They are more or less horizontal and placed at a distance of 2-2.5 mm. from the apex. The ovules of the same scale lie close together, and usually one ovule is bigger than the other (PL. 1, FIG. 1; TEXT-FIG. 4). They are inverted in position with their micropyles facing towards the axis (PL. 1, FIGS. 7, 9). In one of the scales only a single ovule is present (PL. 1, FIG. 1; TEXT-FIG. 4).

The ovular integument (PL. 1, FIG. 1) is quite thick and measures 0.3-0.35 mm.

However, it becomes thin at the proximal face of the ovules (PL. 1, FIG. 10). The integument is probably three-layered; the greater part is formed by a strongly developed sclerotesta (PL. 1, FIG. 8). This is composed of thick-walled, polygonal cells with small lumen (PRAKASH, 1956, TEXT-FIG. 5). The fleshy tissue which, in the present specimens, could be detected on the inner side of the stony layer, is composed of a few layers of thin-walled cells. However, the outer fleshy layer could not be definitely ascertained. Either it is intimately merged with the cone-scale tissue so as to be indistinguishable or it has altogether disappeared at this stage of cone development (COULTER & CHAMBERLAIN, 1910). The integument projects more or less as a ridge at some places (PL. 1, FIGS. 1, 8; TEXT-FIG. 4).

The *endosperm* is seen, in patches, only in some ovules and consists of thick-walled cells (PL. 1, FIG. 3). The *embryo* is not preserved in any of the ovules so far examined.

#### DISCUSSION

So far only a few petrified female cones are known in detail from the Deccan Intertrappean Series. These are *Takliostrobus alatus*, *Indostrobus bifidolepis* and ?*Pityostrobus crassitesta* described by Sahni (1931) from the Hislop and Hunter collection of the British Museum. Sahni (1931) pointed out that the cones of *Takliostrobus* and *Indostrobus* show abietinean features together with certain peculiarities of their own. Hirmer and Hörhammer (1934) and Hirmer (1936) believed that *Takliostrobus* and *Indostrobus* are related to *Cheirolepis* Schimper and *Hirmeriella* Hörhammer of the Rhaetic-Liassic of Franconia. Florin (1940, 1941), however, does not agree with Hirmer's interpretations of the morphology of their cones and thinks that the true systematic positions of all these genera are yet to be determined.

The present cone appears to be distinct from all so far known female conifer cones of fossil as well as living genera and is, therefore, being referred to a new type. However, the fossil cones of *Takliostrobus alatus* and *Hirmeriella rhätoliassica* are worth mentioning for the purpose of comparison. Thus *Takliostrobus alatus*, although resembling the present cone in having winged cone-scales with two embedded ovules, differs from it in the presence of a deeply and irregularly corrugated surface of the wings, in the bract-

scale being fused to the ovuliferous scale along the middle line throughout its length, but free laterally, and lastly in the distal limb of the ovuliferous scale being turned sharply upwards into a thin lamina.

Similarly with *Hirmeriella rhätoliassica* the present cone resembles in having two embedded ovules in the cone-scales. However, the Mohgaon cone also differs from it in the absence of a separate bract and an ovuliferous scale, in the presence of closely placed ridged seeds, thin wings and numerous cavities in the tissue of the scales.

The compact nature of the cone with spiral, overlapping cone-scales expanded horizontally with the margins thinning out into wings, the presence of completely embedded, inverted ovules and the apparently single cone-scales without a bract separated from the ovuliferous scale are features indicating its relationship with the family Araucariaceae. Among the members of this family the Mohgaon cone approaches the genus *Araucaria* (sect. *Eutacta* and *Intermedia*) more closely than *Agathis* because of the cone-scales being laterally winged and the seeds wholly embedded in the tissue of the scales (SEWARD & FÖRD, 1906, pp. 312, 359-361; SEWARD, 1919, p. 111; WILDE & EAMES, 1948; 1952, pp. 41-45).

The presence of two ovules in the cone-scales of the Intertrappean cone does show a marked difference from the uniovulate condition normally found in the Araucariaceae. However, two ovules per scale have also been recorded in living as well as fossil species belonging to this family. Thus in *Araucaria montana* and *A. rulei*, both endemic in New Caledonia, a region rich in archaic forms, two ovules are distinctly present on some of the cone-scales and there is a transition from two-ovuled to normal one-ovuled condition effected in the scales from the base of the cone (MITRA, 1927; FLORIN, 1951, pp. 361-363). This is also found in other species (MITRA, 1927; COULTER & CHAMBERLAIN, 1910, p. 251). Recently Kendall (1949, pp. 155, 158) has reported the occasional presence of two seeds in the cone-scales of *Araucarites phillipsi* Carruthers from the Jurassic (Deltaic Series) of Yorkshire. This shows that the genus *Araucaria* does retain such characters which may be present in their predecessors.

It has been shown both by Mitra (1927) and Florin (1951, p. 363) that the one-seed condition in *Araucaria* is derived and is the

result of reduction from two or three ovules, and Florin (1944, pp. 494-496) has further presented in *Tricranolepis* (ROSELT, 1958) a cone-scale from which that of *Araucaria* may be derived (WILDE & EAMES, 1948, pp. 323-325, TEXT-FIGS. 18-20).

It is, therefore, quite possible that the present cone with usually two ovules per cone-scale, of which one is well developed and larger than the other, and the occasional occurrence of only one ovule may represent a stage in the reduction series close to *Araucaria*, from which the one-seed condition in this genus has been evolved.

### DIAGNOSIS

#### *Mohgaostrobus* nov. gen.

Compact cones with spiral, overlapping scales. Cone-axis with a ring of vascular strands and composed of thin-walled cells towards its periphery. Cone-scales apparently single and without a bract separated from the ovuliferous scale, fleshy, nearly horizontal with the distal limb turned slightly upwards into a thin lamina; thick in the middle, expanded horizontally with the margins thinning out into wings which overlap those of neighbouring scales; cavities present, more numerous in the wings and towards the distal part of the scales than elsewhere. Ovules usually paired (one scale found with one ovule only), inverted, embedded in the scales; usually one ovule smaller than the other; surface ridged. Integument 3-layered, stony layer well developed. Endosperm of thick-walled cells. Embryo not preserved.

#### *Mohgaostrobus sahnii* nov. sp.

General characters as for the genus. Cone short-stalked, about 2.1-2.2 mm. in diameter, with spiral overlapping scales. Cone-axis 2-2.5 mm. in diameter with a ring of about twenty-two vascular strands; peripheral tissue of thin-walled, polygonal cells. Cone-scales apparently single, without a bract separated from the ovuliferous scale, 8.9-5 × 4.5-5 mm. in the widest part, thick in the middle, expanded horizontally with margins thinning out into wings, nearly horizontal with distal limb turned slightly upwards, fleshy, cavities present; epidermis of slightly thick-walled cells, sometimes loosely attached to the scales. Ovules embedded, usually paired, cylindrical, about 3.5-5 mm. long and 1-1.5 mm. broad, placed at a distance of 1-1.5 mm. from the axis, parallel to the subtending scales, with micropyles next to the cone-axis; usually one ovule smaller than the other. Integument thick, about 0.3-0.35 mm., the greater part formed by a well-developed sclerotesta, which becomes thin at the proximal face of the ovule. Endosperm of thick-walled cells. Embryo not preserved.

*Locality* — Mohgaon Kalan in Chhindwara district of Madhya Pradesh.

*Horizon* — Deccan Intertrappean Series.

*Age* — Early Tertiary (probably Eocene).

*Syntypes* — B.S.I.P. Museum Nos. 10650, 31583.

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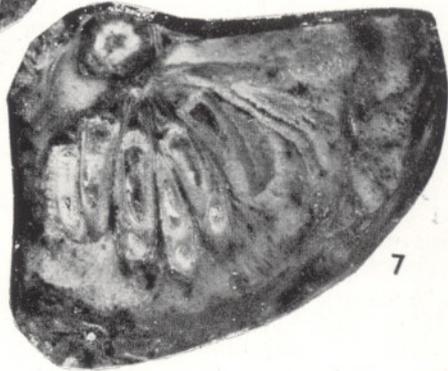
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## EXPLANATION OF PLATE 1

\*1. Tangential section of cone from near the cone-axis. Note only one ovule in one of the scales (*sc. o*) (specimen No. 10650).  $\times 3$ .

2. Cone in Fig. 6 slightly magnified.  $\times 2$ .

\*3. Endosperm cells highly magnified (specimen No. 10650).  $\times 175$ .

4. Cross-section of cone showing cone-axis and two longitudinally cut ovules of a cone-scale. Note cavities in the tissue of the scales (specimen No. 31583).  $\times 4$ .

\*5. Cross-section through the wing of a scale showing loosely attached epidermis and cavities in the tissue of the scale (specimen No. 10650).  $\times 72.5$ .

\*These figures have already appeared in my earlier paper (PRAKASH, 1956), but are reproduced here as such or slightly modified for ready reference.

6. Basal part of cone attached to a short stalk (specimen No. 31583). Natural size.

7. Another cross-section of cone showing cone-axis and cone-scales with ovules and numerous cavities in the distal part of the scales (specimen No. 31583).  $\times 4$ .

8. Tangential section of cone showing two embedded ovules in each cone-scale (specimen No. 31583).  $\times 6$ .

9. Cross-section of cone from near the base to show the cone-axis and cone-scales with embedded ovules (specimen No. 31583).  $\times 4$ .

10. Cross-section of cone magnified to show the cone-axis and cone-scales with two ovules and numerous cavities in the tissue of the scales (specimen No. 31583).  $\times 7.5$ .