

# FURTHER OBSERVATIONS ON *GLOSSOTHECA* SURANGE & MAHESHWARI: A MALE FRUCTIFICATION OF GLOSSOPTERIDALES

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## ABSTRACT

A new species *Glossotheca orissiana* is described. It has a fertile leaf different in shape than that of *Glossotheca utkalensis*. The fertile leaf bears three or more pedicels on the abaxial side of the petiole. Each pedicel bifurcates into two and each fork then further divides by dichotomy and the slender final branches bear one sporangium each. Each pedicel thus bears two sporangial clusters. The sporangia are like those of *Glossotheca utkalensis*. Further observations have been made on *Glossotheca indica* Surange and Maheshwari. It has a larger fertile leaf, spatulate in shape and a very long petiole.

## INTRODUCTION

**S**URANGE and Maheshwari (1970) described a remarkable male fructification, *Glossotheca utkalensis* borne on a small fertile leaf having *Glossopteris* type of venation. This is the only male reproductive organ of Glossopteridales about which we know in detail. Some of Pant's (1958, 1960) isolated sporangia may resemble sporangia of *Glossotheca*, but one cannot be certain about their affinity. Surange's male fructification (1957) is entirely different. *Eretmonia* (Surange & Maheshwari, 1970) is another male fructification, which has one pedicel bearing sporangia.

A fresh collection was made recently from the same locality which yielded several specimens of *Glossotheca*. On examination it was found that, besides fertile leaves of *Glossotheca utkalensis*, there is another type of fertile leaf bearing sporangia. It is, therefore, described as a new species of *Glossotheca*. Further observations have also been made on *Glossotheca utkalensis*.

## DESCRIPTION

Genus — *Glossotheca* Surange & Maheshwari

*Emended Diagnosis* — Male fructification borne on long petiole of small, fertile leaf; lamina spatulate or of different shape; no

midrib, veins diverge from base of lamina, a few veins run in the middle as midveins, midveins and secondary veins bifurcate and anastomose; pedicels borne on the abaxial side of petiole or basal portion of fertile leaf; each pedicel bifurcate, each bifurcation further divides dichotomously; ultimate branches bear one sporangium sporangia in clusters, sporangia oval-elongate with longitudinal markings.

*Type species* — *Glossotheca utkalensis* Surange & Maheshwari.

## 1. *Glossotheca utkalensis* Surange & Maheshwari

Pl. 1, 2, Figs. 1-3, 7

*Emended Diagnosis* — Male fructification; fertile leaf spatulate with round apex and long petiole, lamina 1.5-2.5 cm long, 1-1.5 cm broad; petiole 4-7 cm long and 2-5 mm broad; no midrib but a few strong veins run in the middle then bifurcate and form anastomoses, other veins diverge from base or given out by outer midveins, bifurcate, form small, hexagonal meshes; 3 or more pedicels borne on abaxial side of petiole, one below the other, each pedicel bifurcates, each bifurcation further divides by dichotomy; sporangia elliptical-oval with polar ends bluntly rounded, sporangial surface marked by fine longitudinal ridges and grooves.

We have a number of specimens preserved on grey shales and they are identical with *Glossotheca utkalensis*. Some of them are shown in Pl. 1 & 2, Figs. 1, 2, 3 & 7. The one shown in Pl. 1, Fig. 1 is almost a complete specimen of a fertile leaf, measuring 6.5-7 cm in length. The lamina is spatulate with broadly rounded apex and measures 2.5 cm in length and 1.5 cm in breadth at the broadest part. The lamina gradually tapers down into a long petiole, more than two or more times its length. The petiole is 4-4.5 cm long and 3 to 5 mm broad. It is broader where



TEXT-FIG. 1 — A drawing of the holotype of *Glossotheca orissiana* showing two fertile leaves with forked pedicels. The pedicels of the fertile leaf on the left has forked twice. Also note the attachment of sporangia on slender forks of a penultimate branch.  $\times 6$ .

the pedicels bearing sporangial groups were perhaps attached. No pedicel is seen but sporangial groups are scattered all along the petiole on its either side. A very small leaf 1.2 cm long and 5 mm broad with 2 or 3 strong midveins and anastomosing secondary veins, is lying at the base of the petiole in such a position that it looks as if it was attached to the petiole. Is this a bract in the axil of which the fertile leaf is borne?

Pl. 1, fig. 2 shows another smaller but complete specimen of a fertile leaf of *Glossotheca utkalensis*. The entire leaf measures 5 cm in length, the lamina 1.5×1 cm and the petiole 3.5 cm in length and 2.3 mm in breadth. The lamina is oval-spathulate with bluntly rounded apex. The venation is more clear here. A few strong veins from the petiole enters the lamina and run as midveins up to about half its length. Then they dissolve into smaller veins, bifurcate and form anastomoses. Likewise, the outer veins give out secondary veins which bifurcate and form meshes up to the margin. The meshes are hexagonal and pointed at both the ends. Only one pedicel is seen attached to the petiole. Two groups of sporangial clusters are seen, but no attachment is evident.

Pl. 1, fig. 3 shows another specimen of a fertile leaf of the same species with almost complete lamina which looks somewhat elongated. The venation is well preserved and confirms to the description given above. Only one pedicel is visible, lying in the midst of sporangial clusters. Some sporan-

gia look as if they are lying in a whorl round a central spot.

Pl. 2, fig. 7 shows only the petiole of a fertile leaf of *Glossotheca utkalensis* with three pedicels and clusters of sporangia. One of the pedicel shows bifurcation at a distance of about 5 mm from the petiole. The pedicels are 4-6 cm long and 1 mm broad.

The specimens of *Glossotheca utkalensis* studied by us, clearly shows that three or more pedicels spring from the abaxial side of the petiole of the fertile leaf, in a row, one below the other. Each pedicel bifurcates and most probably goes on dividing repeatedly. The sporangia are probably attached on the ultimate branches. The interpretation of Surange and Maheshwari that one main pedicel arises from the leaf stalk which further gives rise to three pairs of branches is not correct. Each pedicel is attached separately on the petiole. It was not possible to observe how sporangia are attached on the ultimate branches, whether singly or in whorls. The sporangia in our specimens have the same structure as described by Surange and Maheshwari. The organization of the pedicel and the branch system appears to be similar to that of *Glossotheca orissiana* described below.

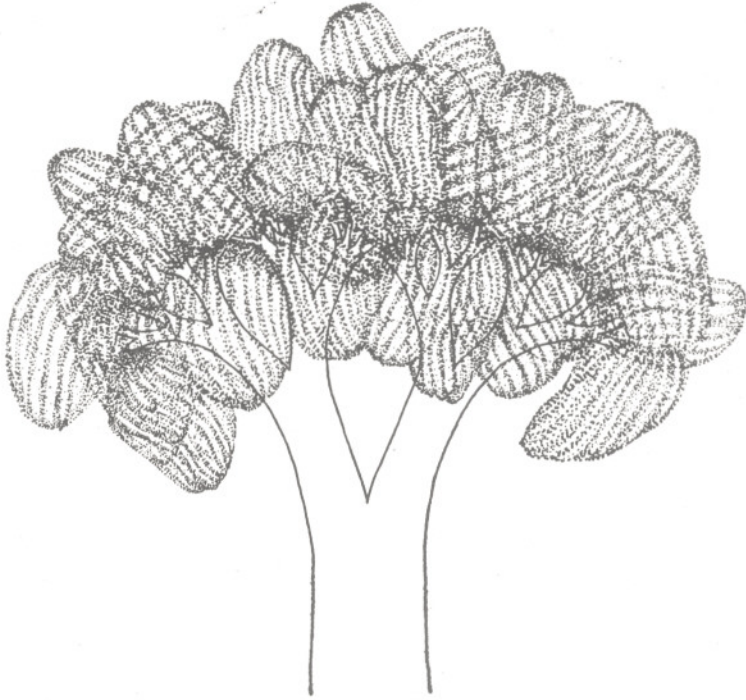
## 2. *Glossotheca orissiana* n. sp.

Pls. 1, 2, 3, Figs. 4-6, 8-12; Text-figs. 1-4

*Diagnosis* — Fertile leaf elongate-lanceolate with drawnout apical end; lamina 1.5-2 cm long, less than 1 cm broad; petiole



TEXT-FIG. 2 — A drawing of two attached sporangia of *Glossotheca orissiana*. × 40.



TEXT-FIG. 3 — A diagrammatic representation of the dichotomous branching of a pedicel. Each ultimate branch bears one sporangium and all sporangia on one pedicel form a cluster as seen commonly preserved on the shale.  $\times 12$ .

3-4 cm long, 3-4 mm broad; veins spreading from base, a few veins in the middle run straight up for short distance before forking and anastomosing, rest of the veins diverge towards margin, forking and anastomosing, meshes elongate, pointed at two ends; 3 or 4 pedicels attached in a single row on abaxial side of petiole, each pedicel forks several times, producing slender ultimate branches; sporangia attached on ultimate branches, one on each branch; sporangia oval-elliptical with prominent longitudinal striations.

*Holotype* — B.S.I.P. No. 35039

In the same collection from Orissa, there are a number of specimens with a fertile leaf of different shape than that of *Glossotheca utkalensis* preserved on whitish compact shales. The shale pieces on which *Glossotheca utkalensis* are preserved are grey in colour and were collected at a different level from the same fossiliferous bed which is about 15'-20' thick.

Pl. 2 fig. 8 shows a fertile leaf of *Glossotheca orissiana* showing the typical shape of the lamina. The apical part is drawn

out into a pointed apex (see also Pls. 2, 3; Figs. 6, 9) as against a broadly rounded apex of *Glossotheca utkalensis*. The lamina narrows down into a thick petiole. The venation is well preserved. A number of veins enter the lamina from the base and, except for a few veins in the middle, spread out towards the margin, forking and anastomosing. A few veins in the middle go straight upwards almost upto half the length of the lamina, then starts forking and anastomosing. The meshes in the upper half of the lamina are arranged end to end, two or three entering the drawn out apical end (Pl. 2, Fig. 6). The petiole or the basal part of the fertile leaf is shorter than that of *Glossotheca utkalensis*. A few sporangial clusters are seen, but no pedicel is visible.

Pl. 2, fig. 5 shows a well preserved specimen showing two well preserved fertile leaves lying side by side. This is the holotype of *Glossotheca orissiana* (see Text-fig. 1). Pl. 2, fig. 6 shows one fertile leaf and Pl. 3, fig. 9 shows the other leaf with forked pedicels and clusters of sporangia.

The fertile leaf in Fig. 6 is small and about 3 cm long with a part of the petiole preserved on another shale piece. The lamina is 1.5 cm long and about 7-8 mm broad. Meshes in the apical region of the lamina are clearly seen, arranged end to end. The leaf tapers down into a petiole, 3 mm in breadth. Two forked pedicels are attached at a distance of 8 mm. One pedicel springs out almost at the base of the lamina and forks immediately. The forks are embedded below two sporangial clusters and therefore, further branching is not visible (Text-fig. 1).

The other fertile leaf shown in Pl. 3, fig. 9 is also elongate with a long, drawn out apex. The entire leaf measures 2.5 cm in length; the lower part of the petiole is missing. The lamina is 1.8 cm long, the drawn out apex being 3 mm in length. The petiole is 2 mm in breadth and shows beautifully preserved two forked pedicels, about 7 mm apart (Pl. 2, Fig. 5; Text-fig. 1). The pedicels are 1 mm in breadth and fork after about 2-3 mm distance from the petiole. The pedicel (Pl. 3, Fig. 9) which is attached near the base of the lamina is shown enlarged in Pl. 3, fig. 10 with groups of sporangia lying nearby. The pedicel is forked and the forks are reduced to almost half in breadth. The upper branch of the fork on the left has gone under the groups of sporangia, but the lower branch shows second bifurcation. This pedicel has, therefore, forked twice. The other pedicel also shows two bifurcations (Text-fig. 1). Pl. 3, fig. 9 shows two sporangia (see arrow on the left bottom) each attached to a slender branch of the fork, about 0.1 mm in breadth (Text-fig. 1). The attached sporangia are shown enlarged in Pl. 3, fig. 11 and Text-fig. 2. The ultimate branches of the pedicels are thus forked. It, therefore, follows that the pedicel divides repeatedly by dichotomy and the slender ultimate branches bear sporangia. The main pedicel is 1 mm broad and it must be dividing four to five times before the size of the ultimate branch, about 0.1 mm as seen in Pl. 3, fig. 11, is reached. The number of sporangia on each cluster, therefore, should not exceed 32. The accurate count was not possible but the sporangia counted in many clusters did not exceed 32. The sporangia in *Glossotheca orissiana* thus are borne on the ultimate branches of a dichotomous branch system.

This has been shown diagrammatically in Text-fig. 3.

Forked pedicels are also seen in another specimen (Pl. 1, Fig. 4) in which the lamina is not preserved. The pedicels are attached to a petiole and are embedded under sporangial clusters.

In Pl. 3, fig. 12 and Text-fig. 2 are illustrated two sporangia enlarged to show their structure. The sporangia are elongated, about 1 to 1.5 mm in length. They also appear oval, their shape depending upon the way they are flattened. Generally one side is semicircular and the other is straight, the polar ends are drawn out and rounded. The sporangial surface is marked by fine longitudinal striations which appear as ribs and grooves. Many isolated sporangia which have been described by various authors, show this character prominently. This type of sporangia are very common in the *Glossopteris* flora.

#### RECONSTRUCTION

Text-fig. 4 shows a restoration of a fertile leaf and sporangia of *Glossotheca orissiana*. Three pedicels are shown arising from the abaxial side of the basal part of the fertile leaf, the upper one springing almost from the base of the lamina. Each pedicel forks and the daughter branches are hidden under the crowded groups of sporangia. Text-fig. 3 shows diagrammatically how a pedicel branches five times by repeated dichotomy. Subsequent dichotomies occur at much shorter distances and hence the sporangia in the group look crowded, burying dichotomous branches under them.

#### COMPARISON AND DISCUSSION

*Glossotheca orissiana* resembles closely the other species from the same locality, *Glossotheca utkalensis*. Both are male reproductive organs carrying sporangia on branched pedicels. In both, the pedicels are borne on the abaxial side of the petiole or the basal part of the fertile leaf and the sporangia in the two species look almost identical. *Glossotheca orissiana*, however, differs from *Glossotheca utkalensis* in being smaller in size, the fertile leaf and petiole in the latter are much longer. The most important difference lies in different shapes the two fertile leaves have in the two species. It would be difficult to imagine that one species



will carry two different types of fertile leaves. Further, the number of sporangia in *Glossotheca orissiana* does not exceed 32, whereas the number in *Glossotheca utkalensis* is given as  $\pm 100$ . Even if it is assumed that the number in the latter could be less, it would certainly be much higher than that of *Glossotheca orissiana*. The pedicels bearing sporangia are borne in the same way on the fertile leaves in both the species. But the occurrence of sporangia in whorls in *Glossotheca utkalensis*, if correct, suggest that 4 or more sporangia are borne on one ultimate branch (this fact may explain large number of sporangia on each pedicel), whereas in *Glossotheca orissiana* only one sporangium is borne on each ultimate branch. There is no doubt, however, that these two types of fertile leaves belonged to closely related plants. If, however, one goes by the resemblance of sporangia, both the fertile leaves will have to be kept under one species.

Other fructifications of Glossopteridales like *Scutum* and *Cistella* are borne on fully developed sterile(?) *Glossopteris* leaves on their abaxial surface, their stalks being attached almost to the midrib in the basal region of the leaf. Sporangia bearing pedicels in *Glossotheca* are also borne on the abaxial surface, attached by their stalks in the region of midveins of small fertile leaves. The fructifications such as *Scutum*, *Cistella* and *Glossotheca*, therefore, are borne in the same manner.

The sporangia are attached on fertile branch system in some pteridosperms such as *Diploteridium teilianum*. In *Glossotheca* also sporangia are borne on a branch system. But the resemblance-between the two ends here. In *D. teilianum* synangial discs are borne on slender rachises with wide angled forkings, whereas in *Glossotheca orissiana* one sporangium is carried on each slender brach.

*Eretmonia* of Du Toit (1932) has been regarded as male fructification by Surange and Maheshwari (1970). It has small, stalked fertile leaves with dichotomous venation. Although there is no evidence of a pedicel carrying sporangia attached to the stalk of the fertile leaf, there appears to be fair chances of this being the case. However, *Glossotheca* has more than one pedicel attached in a row on the fertile leaf, whereas *Eretmonia* appears to have only one forked pedicel. Further comparison cannot

TEXT-FIG. 4 — Restoration of *Glossotheca orissiana*.  
× 6.

be made as *Eretmonia* is not known in detail.

In the fossil locality from where *Glossotheca* has been collected, no species of *Gangamopteris* is present. On the other hand *Glossopteris* dominates the flora. It is undoubtedly difficult to relate fertile leaves with sterile leaves of *Glossopteris*, unless they are found in organic connection. Most

of the scale leaves (including fertile leaves) present in our collection do not have solid midrib like that of *Glossopteris* leaves, but many show profuse anastomoses. The venation pattern in the two categories is different. However, there can be hardly any doubt that *Glossotheca* is the male reproductive organ of one of the species of *Glossopteris*.

#### REFERENCES

- PANT, D. D. (1958). Structure of some leaves and fructifications of *Glossopteris* Flora of Tanganyika. *Bull. Brit. Mus. nat. Hist. (Geol.)* 3 (4): 127-173.
- PANT, D. D. & NAUTIYAL, D. D. (1960). Some seeds and sporangia of *Glossopteris* flora from Raniganj coalfield. *Palaeontographica*. 107 B: 41-64.
- DU TOIT, A. L. (1932). Some fossil plants from the Karoo system of South Africa. *Ann. S. Afr. Mus.* 28: 370-393.
- SURANGE, K. R. & MAHESHWARI, HARI K. (1970). Some male and female fructifications of *Glossopteridales* from India. *Palaeontographica*. 129 B: 178-191.
- SURANGE, K. R. (1958). Studies in the *Glossopteris* flora of India—9. A male fructification bearing monoete spores from the Lower Gondwanas of India. *Palaeobotanist*. 6: 47-48.

#### EXPLANATION OF PLATES

##### PLATE 1

1. A complete fertile leaf with rounded apex *Glossotheca utkalensis*. Note sporangial groups on either side of the petiole.  $\times 2$ .
2. Another complete specimen of *Glossotheca utkalensis* showing one pedicel attached to the long petiole (see arrow).  $\times 2$ .
3. A specimen of *Glossotheca utkalensis* showing well preserved venation and large groups of sporangia.  $\times 2$ .
4. A petiole (lamina is not preserved) of a *Glossotheca orissiana* fertile leaf showing three attached pedicels and groups of sporangia.  $\times 3$ .

##### PLATE 2

5. A piece of shale showing two fertile leaves and groups of sporangia of *Glossotheca orissiana*. Forked pedicels are attached on the petiole of each leaf. Holotype B.S.I.P. No. 35039.  $\times 4$ .
6. One of the leaf shown in fig. 5 enlarged. Note the drawn out leaf apex and the anastomosing veins. Two forked pedicels (see arrows) are clearly seen.  $\times 5$ .

7. A petiole (lamina is not preserved) of a fertile leaf of *Glossotheca utkalensis* showing three pedicels (see arrows) attached on the petiole and groups of sporangia.  $\times 3$ .

8. Another specimen of *Glossotheca orissiana* showing the typical shape of a fertile leaf. Groups of sporangia are seen lying nearby.  $\times 2$ .

##### PLATE 3

9. Another fertile leaf of *Glossotheca orissiana* enlarged from Fig. 5, Plate 2. Note a beautifully preserved formed pedicel. Also note two sporangia attached on two slender forks on the leaf (see arrow).  $\times 5$ .

10. The forked pedicel seen in Fig. 9 enlarged. The fork on the right side has branched twice (see arrows).  $\times 8$ .

11. Two sporangia seen in Fig. 9 enlarged to show their attachment to slender forks.  $\times 20$ .

12. Two sporangia seen in Fig. 11 in different focus to show their surface structure.  $\times 20$ .



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4





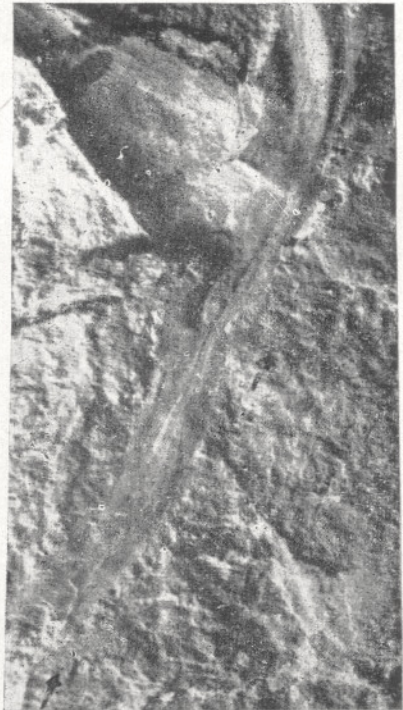
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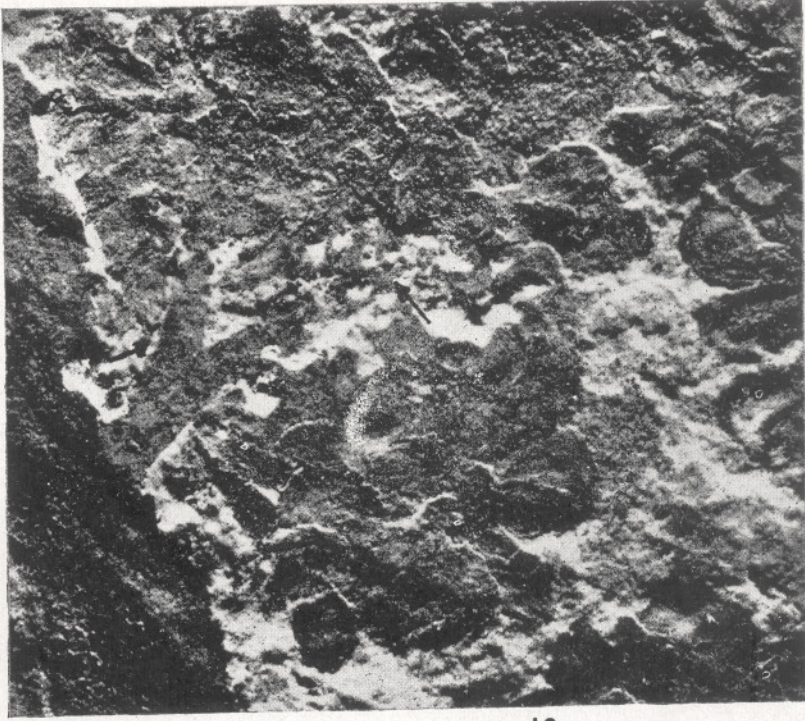
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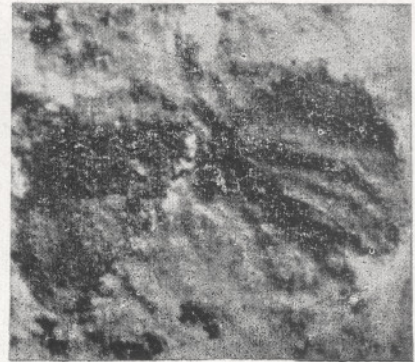
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