SOME MALE FRUCTIFICATIONS OF GLOSSOPTERIDALES

K. R. SURANGE & SHAILA CHANDRA
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

A long, slender, stalked cylindrical male fructification, described earlier by Surange (1957), has been named here as *Kendostrobus cylindricus* gen. et sp. nov. 4-5 sporangia are arranged in whorls and these whorls are borne in close spirals on the cone axis. Its monolete, striped spores are named *Kendosporites*. A new species of *Eretmonia*, *E. ovata*, another male fructification, is also described. It is shown that in *Eretmonia*, as in *Glossotheca*, the sporangia are carried on the ultimate branches of a dichotomizing branch system.

INTRODUCTION

ARBER (1905) was the first to discover from Australia retort-shaped sporangia associated with the scale leaves of *Glossopteris browniana*, agreeing more closely with the microsporangia of a cycad. Du Toit (1932) described a scale leaf as *Eretmonia*, which bore sporangia similar to those described by Arber and regarded it as the male fructification of *Glossopteris*. Recently Pant and Nautiyal (1906) placed the retort-shaped sporangia of Arber under a new generic name *Arberiella* and showed that they contain two winged pollen grains. Earlier Sen (1955) had also found two winged pollen grains in detached, ex-annulate sporangia which he attributed to *Glossopteris*. Sen (1956) also described another type of unilocular, ex-annulate sporangia which dehisced in a longitudinal direction from the apex, liberating *Pityosporites* type of pollen grains.

In 1957, Surange described a new type of male fructification without naming it. It consisted of a long, fleshy axis on which were embedded exannulate sporangia, containing striated, monolete spores. Pant and Nautiyal (1960) found detached unilocular sporangia containing similar type of monolete spores as those in Surange's fructification. They placed these sporangia under a new name *Lithangium*. Pant and Nautiyal (1960) also instituted another genus of detached sporangia, *Polytheca*, which contained triradiate, monocolpate spores. Fructification which bore *Polytheca* is not known.

Surange and Maheshwari (1970) recently described two species of *Eretmonia* from India which differed from each other in the shape and size of their fertile leaves. They bore sporangia in two clusters carried on a pair of branches which were attached on the leaf stalk. The sporangia were found in groups of 6 to 8.

Another male fructification of *Glossopteris* known from India is *Glossotheca* (Surange & Maheshwari, 1970; Surange & Chandra, 1974). It consists of a stalked fertile leaf with *Glossopteris* type of venation. The stalk of the fertile leaf bears three or more pedicels. Each pedicel bifurcates into two branches and eacq branch further divides by repeated dichotomy. The final slender branches bear one sporangium each.

These are the only records of sporangia and male fructifications with suspected affinities to Glossopteridales. In our collections from Orissa, some better specimens of *Eretmonia* were found which gave indications as to the attachment of sporangia on ultimate branches. Further, the type material of the male fructification described by Surange (1957) from Raniganj was re-examined which revealed the attachment of sporangia. These two types of male fructifications, which in all probability belonged to Glossopteridales, are described below.

DESCRIPTION

Kendostrobus gen. nov.

Male fructification, Surange, 1957, p. 47, 48, Pl. 1, Figs. 1 & 2

Diagnosis — Long, slender, stalked, cylindrical cone bearing spirally arranged naked, exannulate sporangia in groups; sporangial surface covered with minute pits; spore oval, elliptical to subcircular, monolete with longitudinal stripes on its surface.

Type species: — *Kendotrobus cylindricus* gen. *et* sp. nov. (Pl. 1; Figs. 1, 2).

Specific Diagnosis — Male cone, cylindrical, 4 cm long, 5 mm broad, borne on long stalk; 4 to 5 sporangia attached in whorl on small hemispherical projections on cone axis; sporangia ex-annulate, crowded large 2-2·5 mm long; spores oval to elliptical, monolete with longitudinal, parallel running stripes.

Holotype — B.S.I.P. No. 19512.

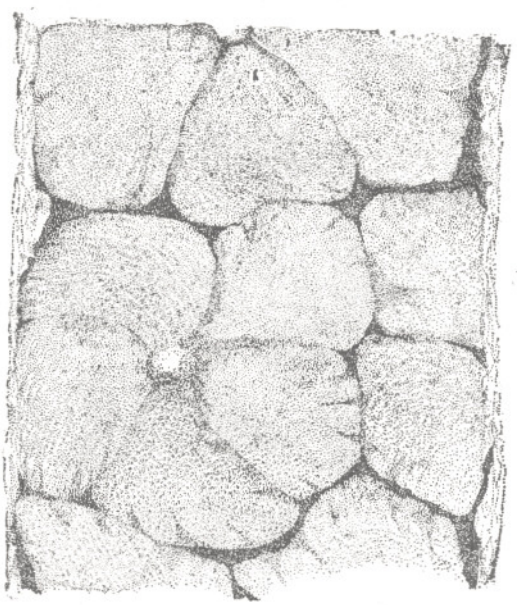
Locality — New Kenda Colliery, Raniganj coalfield.

Horizon — Raniganj Stage.

The fructification was preserved in the form of compression. In the type material the cone was lifted from the shale and was mounted on a slide separately. The impression left behind by the cone on the shale, when examined under strong reflected light, revealed how the sporangia were attached on the axis. (Pl. 1, Fig. 1). The fructification is a long, slender cone, borne on a long stalk. Its parent plant is unknown. The long, slender stalk is 1 mm in breadth and more than 1·5 cm in length. The cone itself is 4 cm long and about 5 mm broad, narrowing upwards into an acute apex. In living condition the cone must have been a slender, cylindrical organ.

Pl. 1, Fig. 2 shows an enlarged photograph of a part of the cone impression on the shale. Impressions of sporangia are clearly visible at some places. On closer examination groups of 4-5 sporangia are seen arranged in whorls around a small, circular protuberence on the cone axis (Text-fig. 1). This explains the arrangement as described by Surange (1957, p. 47) earlier that some sporangia pointed their narrow ends towards the base, while in others they were pointed towards the apex. The whorl of sporangia occupies almost the entire breadth of the cone. The groups of sporangia are borne in close spirals, so that the sporangia appear crowded on the cone surface. No scale or a vegetative leaf is found associated with the cone, but there is present a thick ridge all along its margin (Text-fig. 1). Is it the remnant of a scale leaf similar to that of *Dictyopteridium*? If it is so then this cone is also protected by a spathe-like covering in young stage.

The sporangia are ex-annulate and are borne naked on the cone. They are oval in shape with one end narrower than the other. The end which is attached to the proturberance on the cone is generally narrower. The sporangial surface, unlike those of *Glossotheca* and *Eretmonia*, in studded with tiny, oval to circular depressions. A sporangium measures 1·5 to 2·5 mm. in length and about 1-1·5 mm in breadth.



TEXT-FIG. 1 — *Kendostrobus cylindricus* gen. et sp. nov. showing sporangial arrangement on the cone. × 12·5.

We tried to isolate sporangial wall by controlled maceration of the sporangial mass taken out from the compressed cone, but could not recover any cellular tissue. Pant and Nautiyal (1960) who described some detached sporangia under the name *Lithangium surangei*, also did not give details of the sporangial surface cells. The spores of *Lithangium* are identical with the spores from the male fructification (Surange, 1957) described here as *Kendostrobus cylindricus* and therefore, it is safe to assume that the *Lithangium* type of sporangia were attached on the cone of *Kendostrobus cylindricus*. The sporangia of *Lithangium surangei* are described as round to oval, 1·2 mm × 1·07 mm in size which are somewhat smaller than those on the cone. The slight difference in size between the sporangia of *Kendostrobus* and those of *Lithangium surangei* is insignificant. The surface cells appear to be thin walled and therefore, easily destroyed in maceration as is indicated by the fact that Pant and

Nautiyal did not find them and we also failed to recover them from the remaceration of the type material.

Monolete spores similar to those derived from *Kendostrobus cylindricus* have geen found in isolated condition al o from the Raniganj Stage of India. Bharadwaj (1962) figured one such spore under the name *Latosporites* sp., a genus from the nortrhern hemisphere. The parent fructification which produced this type of spore is a southern hemisphere plant, most probably belonging to Glossopteridales. We therefore, propose a new generic name *Kendosporites* for the reception of such spores.

Turma — *Monoletes* Ibrahim 1933
Subturma — *Azonomonoletes* Luber, 1935
Infraturma — *Perinomonoliti* Erdtman, 1947
Genus — *Kendosporities* gen. nov.
Genotype — *Kendosporites striatus* (Salujha) comb. nov.

Generic Diagnosis — Monolete spore, generally oval to subcircular; unmacerated spore with thick, irregular, sculptine ridges running parallel to longitudinal axis; macerated spore with parallel stripes in place of ridges parallel to monolete slit; exine smooth.

Type species — *Kendosporites striatus* (Salujha) comb. nov. (Pl. 1 & 2; figs. 7-25)

Specific Diagnosis — Spore oval, elliptical to subcricular; size 55μ-110μ × 50μ-90μ; sculptine folded into thick, sometimes broken, slightly curved, ridges and grooves, running parallel to longitudinal axis; during maceration sculptine ridges destroyed, leaving behind longitudinal stripes on body; exine up to 1·5μ thick, laevigate, irregularly folded; monolete mark parallel to stripes, when open extends up to 3/4th of longer axis.

Neotype — 1952 B.S.I.P. Collection (Surange's slide).

Locality — New Kenda colliery, Raniganj coalfield, Bengal.

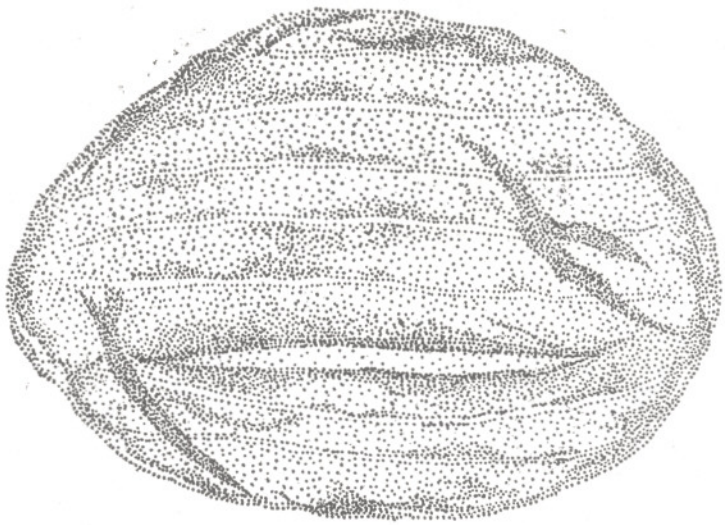
Horizon — Raniganj Stage.

Description — A small part of the sporangial mass from the cone of *Kendostrobus cylindricus* was treated with HNO_3 for a few minutes and then some spores were taken out, washed and mounted on a slide. The acid had acted very little on the spores and the sculptine remained almost intact. The spore looked dark brown and the sculptine was folded into a number of thick, dark, somewhat arched ridges, running, parallel to the longitudinal axis of the spore

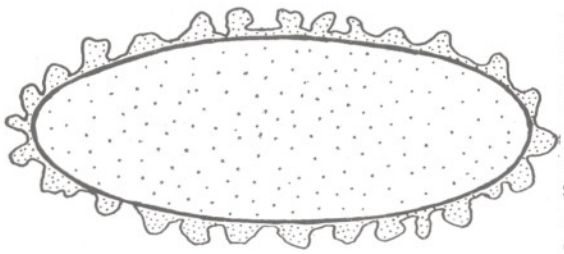
TEXT-FIG. 2 — *Kendosporites striatus* comb. nov. unmacerated spore showing sculptine ridges. × 1000.

(Pl. 2, figs. 9, 12, 14; Text-fig. 2). The grooves in between the ridges perhaps denoted unthickened part of the spore wall, which appeared as thin transparent stripes (Text-fig. 3) between the dark ridges. When remaining spores were subjected to further maceration, the sculptine dissolved completely, leaving behind long, thin stripes on the spore wall in place of ridges and grooves. It seems that the areas of sculptine ridges still remained darker after, maceration than the unthickened part (grooves) of the exine and they appear as lighter lines, imparting a striped appearance to the spore. In over macerated spores, even the stripes tend to disappear, giving a smooth appearance to the spore surface A diagrammatic cross section of a spore is shown in Text-fig. 4.

Spores were compressed in different ways which gave different shapes to the spores. Some of them are figured in Pl. 1 & 2, Figs. 7-25. There is also a considerable variation in size and surface features. The smallest spore measure 56 × 50 μ (Pl. 1, fig. 8) and the largest was 107 × 90μ. Very



TEXT-FIG. 3 — *Kendosporites striatus* comb. nov. macerated spore showing stripes, monolete mark and folds. × 1000.



TEXT-FIG. 4 — Diagrammatic cross section of *Kendosporites striatus* comb. nov. showing uneven sculptine ridges. Monolete mark is shown on the upper left side.

often the spores are compressed in such a way that monolete mark is not at all visible. In such a condition, the spore, could easily be mistaken for an alete form. The slit is lens shaped, convex in the middle and pointed at both ends and almost extending up to the margin. The exine is generally folded and one to three major folds appear on any part of the spore body.

Comparison and discussion — In 1957, Surange described these spores from a male cone without naming them. Bharadwaj (1962, Pl. 4, fig. 64) illustrated the same type of monolete, striped spore as *Latosporites* sp. from the coals of Raniganj Stage. Later in 1964, Bharadwaj and Salujha recorded a similar spore as *Latosporites* sp. form seam VIII of the Raniganj coalfield. In 1965, Salujha also found the same type of striped, monolete spore from seam IX of the East Raniganj coalfield and named it as *Latosporites striatus* sp. nov. There is hardly any doubt that all these spores are identical with the striped, monolete spores isolated from the male cone (Surange, 1957) now described as *Kendostrobus cylindricus*.

Kendosporites differs from *Laevigatosporites* in possessing sculptine ridges and grooves or stripes on its body. A separate genus *Latosporites* was established by Potonié and Kremp (1954) for those monolete spores which could also be accomodated under Schopf, *et al.* (1944) large genus *Laevigatosporites*. The genotype is *Latosporites latus* (Kosanke, 1950, Pl. 5, fig. 11) from the Upper Carboniferous (Pennsylvanian) and the type locality is from the northern hemisphere (Illinois, U.S.A.). The important generic characters of *Latosporites* are circular to subcircular shape, distinct monolete mark and laevigate to infrastructered exine. The southern *Kendosporites* could easily be distinguished from the northern *Latosporites* by the presence of prominent stripes and in possessing invariably a smooth spore wall. Furthermore, the striped spores occur in the Upper Permian of the southern hemisphere and now known to have belonged to a plant which could not have flourished in the northern hemisphere. The

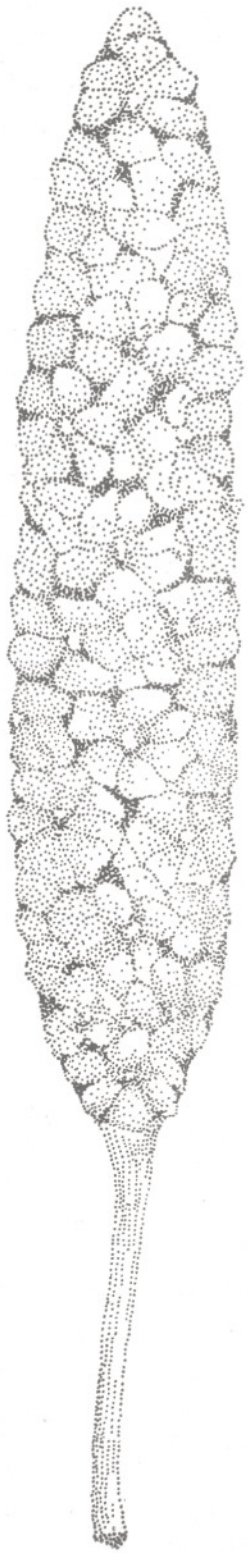
southern striped, monolete spore, therefore, is distinct from the northern Upper Carboniferous genus *Latosporites* and so a new generic name *Kendosporites* is proposed here for their reception.

Another genus *Luenaites* was established by Bose and Kar (1967) for monolete spore from the Palaeozoic of Congo. It differs from *Kendosporites* in the absence of stripes and in having punctate exine.

There is hardly any doubt that the striped spore described by Salujha (1965) as *Latosporites striatus* is identical to those obtained from the cone *Kendostrobus*. Although the single spore figured by Salujha (1965) is a little longer (longer axis 95-120μ) than the average spore of ours and possessed fewer stripes, these differences are insignificant. In our slides also many spores are much smaller and some much larger in size which depended on how the spores were compressed. Moreover, the number of stripes also vary in different spores; half a dozen stripes may become prominent while the others remain indistinct. The difference, therefore, are hardly sufficient to keep these two types under two different species. We have, therefore, merged them under *Kendosporites striatus* comb. nov.

Reconstruction — Text-fig. 5 shows a reconstruction of the cone of *Kendostrobus cylindricus*. The cone is compact, long, narrow, almost cylindrical organ which is attached on a long, slender stalk. Text-fig. 1 shows the mode of attachment of sporangia on the cone. 4 or 5 sporangia are attached in whorls to small knob-like protuberances on the cone axis. The sporangia are large, arranged in close spirals and appear crowded on the cone.

Comparison — *Kendostrobus cylindricus* is quite different from the other two known male fructifications, *Glossotheca* and *Eretmonia* assigned to Glossopteridales. *Kendostrobus* is a cone in which groups of sporangia are compactly arranged in close spirals on the cone axis, whereas in *Glossotheca* and *Eretmonia*, the sporangia are carried on a branched system, one sporangium being attached on each ultimate branch.



→

TEXT-FIG. 5 — Reconstruction of *Kendostrobus cylindricus* gen. et sp. nov. × 4.

Furthermore, *Glossotheca* and *Eretmonia* bear sporangia whose surfaces are marked by longitudinally running parallel lines. Such sporangia when found in isolated condition are assigned to the genus *Arberiella*. They have elongated surface cells and contain two winged spores (Pant & Nautiyal, 1960). The sporangial surface of *Kendostrobus*, on the other hand, is studded with tiny, oval to circular depressions, giving it almost a spongy look. The genus *Lithangium*, to which isolated sporangia of *Kendostrobus* are referred, possesses relatively short sporangial cells and contain monolete spores. The arrangement of sporangia in whorls are also described in the genus *Perezlaria* by Delevoryas and Gould (1971) from the Middle Jurassic of Mexico, which are associated with leaves referable to *Glossopteris*. However, apart from similarity in the whorled arrangement of sporangia, there is absolutely no comparison whatsoever between *Kendostrobus cylindricus* and *Perezlaria oaxacensis* Delevoryas & Gould. The organization of *Kendostrobus* is thus quite different from those of *Glossotheca*, *Eretmonia* and other known male fructifications. Surange's (1957) original fructification, therefore, has been assigned here a new name.

It is true that this male reproductive organ has not been found attached to any scale leaf or a vegetative leaf as *Glossotheca* and *Eretmonia* which have been discovered borne on fertile scale leaves possessing *Glossopteris* type of venation. However, gymnospermic character of *Kendostrobus* cannot be doubted. The whole organizations of the fructification, viz., the aggregation of ex-annulate sporangia on a compact cone-like organ points to it's affinity with some gymnospermous plants. Glossopteridales is the dominant gymnospermous group present in this flora from Raniganj and it is likely that this male fructification may have also belonged to Glossopteridales.

Genus — *Eretmonia* Dutoit

Surange and Maheshwari (1970) emended the diagnosis of Du Toit's South African genus *Eretmonia* and described two species from India *Eretmonia utkalensis* and *Eretmonia hinjridaensis*. They also described another species *Eretmonia karanpurensis* from the Karanpura coalfield. We found a few more specimens of the first two species of *Eretmonia* from Orissa, which provided more details about it's structure. Besides, there is one more fertile scale leaf which is distinct from the other two species and so described below under a new specific name.

Eretmonia utkalensis Surange & Maheshwari

Pl. 1, fig. 3

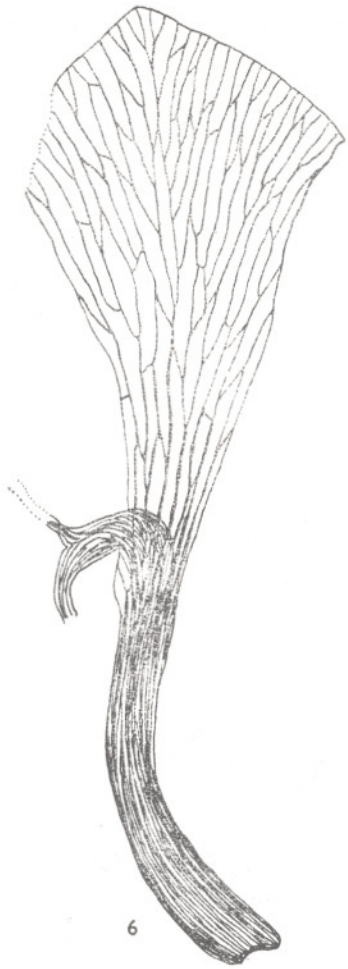
Pl. 1, fig. 3; Text-fig. 6 shows a fertile scale leaf of this species possessing characteristic short, diamond shaped lamina with an acute apex and a long stalk. The leaf is almost of the same size as described by Surange and Maheshwari (1970). Our specimen is 3·1 cm long and lanina is 8 to 10 mm. broad at the widest part. The stalk is 1·5 to 1·7 cm long and 2 mm broad. The thick lamina shows venation clearly (Text-fig. 6). There is no midrib, but about half a dozen vascular bundles enter the lamina from the stalk and bifurcate immediately into a dozen bundles. They diverge bifurcating twice or thrice, meeting one another and forming meshes. The bundles thin out towards the margin. The meshing is very distinct.

From near the base of the lamina arises a pedicel which is 1 mm in breadth. About 2 mm of it's entire length is preserved, but within this length the pedicel bifurcates (Text-fig. 6) into two branches, each brach is almost half its width. Neither further branching nor sporangial groups are preserved in our specimen. One thing is clear and that is only *one* pedicel is present in *Eretmonia utkalensis* as against three of four pedicels in *Glossotheca* Surange & Maheshwari. The two daughter branches must have further divided dichotomously to carry two sporangial clusters.

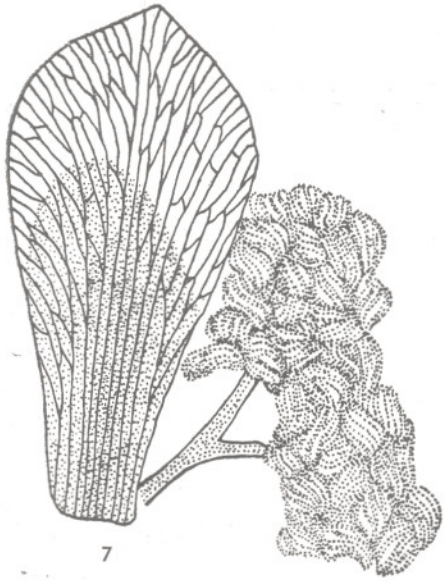
Eretmonia hinjridaensis Surange & Maheshwari

Pl. 1, fig. 6

Pl. 1, fig. 6; Text-fig. 7 shows a specimen of *Eretmonia hinjridaensis* in our collection. The fertile scale leaf is without a stalk, which shows that fructification bearing scale leaves were abscissed from the stalk once the pollen were released. The lamina is spathulate and broadest near the apex, the margins converging into an acute apex, which is



6



7

not seen clearly in the type specimen. The lamina measures 1·7 cm in length and the maximum breadth reaces 7 mm, whereas at the base it is only 3 mm. The venation in our specimen is clearly preserved. About 8 or 9 strong vascular bundles enter into the lamina (from the stalk) and run straight upwards. The outer bundles give out secondary veins which dichotomise two or three times, anastomosing with the neighbouring bundles and forming meshes. In this species also the net venation is very clear.

Two sporangial clusters (Text-fig. 7) are seen here lying on the right side of the fertile scale leaf. There is a faint indication of a pedicel at the base of the lamina, bifurcating a little further up, and the daughter branches disappearing beneath the sporangial clusters. The sporangia are of same type as described by Surange and Maheshwari (1970). They are small and oval, showing parallel lines along the long axis. The sporangia look very much like those of *Arberiella* type described by Pant and Nautiyal (1960). This type of sporangia are common in the Glossopteris flora and were first recognized by Arber in 1905 *Glossotheca* also possesses *Arberiella* type of sporangia. Although no spores were present in our material, Pant and Nautiyal (1960) had earlier described two winged pollen grains from the *Arberiella* type of sporangia. It may, therefore, be safe to presume that both *Glossotheca* and *Eretmonia* also produced two winged pollen grains.

Eretmonia ovata sp. nov.

Pl. 1, figs. 4 & 5

Diagnosis — Male fructification; fertile scale leaf large, lamina ovate, 2·5 cm long, maximum breadth 1·6 cm; one pedicel bearing sporangial clusters branch by repeated dichotomy, one sporangium borne by each slender ultimate branch.

Holotype — 35143

Locality — Hinjrida Ghati, District Dhenkanal, Orissa.

←

TEXT-FIG. 6 — Fertile scale leaf of *Eretmonia uthalensis* Surange & Maheshwari showing venation and dichotomizing pedicel. × 4.

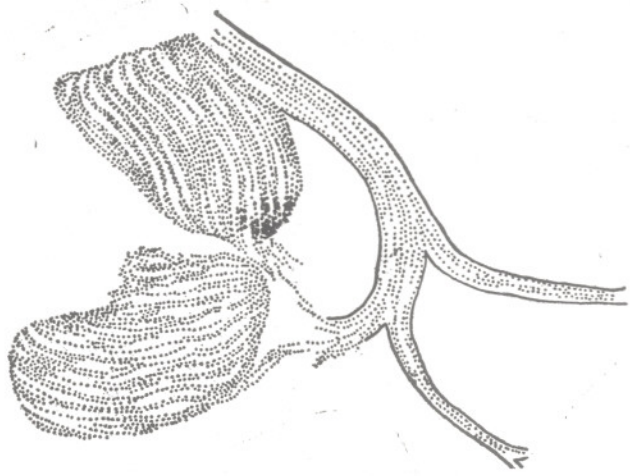
TEXT-FIG. 7 — Fertile scale leaf of *Eretmonia hinjridaensis* Surange & Maheshwari showing venation and depression in the middle of the lamina. Note two sporangial clusters borne on a bifurcating pedicel. × 4.

TEXT-FIG. 8 — Fertile scale leaf of *Eretmonia ovata* sp. nov. Note dichotomizing branches and two sporangia on the left side and a branch on the right side. Lamina shows depression in the middle and venation at the margin × 4.

Horizon — Raniganj Stage.

Description — The fertile scale leaf (Pl. 1. fig. 4, 5; Text-fig. 8) is much larger than the scale leaves of *E. utkalensis* and *E. hinjridaensis*. The leaf without stalk measures 2·5 cm long and 1·6 cm broad at the widest part. The apical part forms a triangle with an actue apex. The venation is preserved only at some places towards the margin. The secondary veins dichotomise, anastomose with neighbouring veins and form meshes. The central bundles must have been similar to those in other species of *Eretmonia*.

One cluster is seen lying at the bottom with one branch of pedicel, 5 mm long and 5 mm broad (Pl. 1, fig. 4; Text-fig. 8). The pedicel is not actually attached to the fertile scale leaf, but it appears that it had broken off. There is, however, hardly any doubt that the sporangia were borne on this scale leaf. There are also some finer branches and some sporangia preserved on the other side of the leaf. Text-fig. 8



TEXT-FIG. 9 — A branch bifurcates thrice and the ultimate branches in one bear one sporangium each at their apices. × 20.

TEXT-FIG. 10 — Drawing of a dichotomously dividing branching system of a pedicel of *Eretmonia* bearing sporangia on the ultimate branches. × 15.

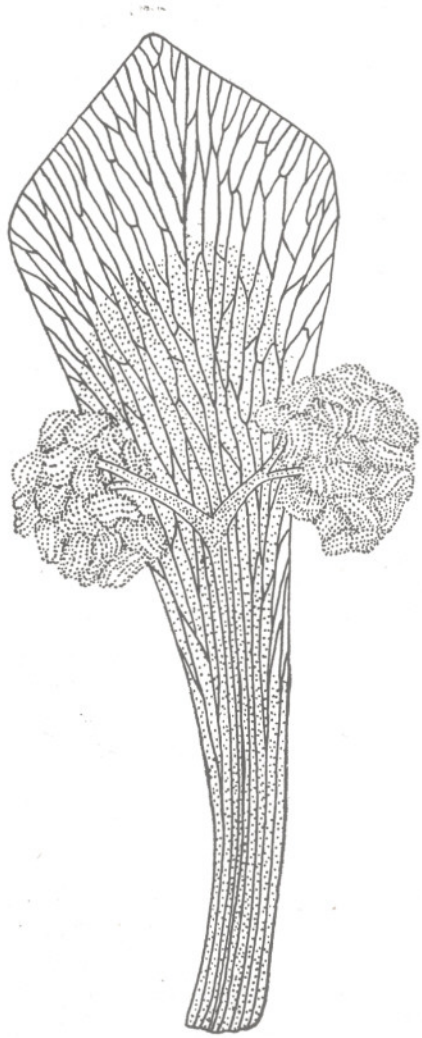
shows one slender branch of pedicel which bifurcates three times and the ultimate bifurcation carries one sporangium on each branch (Text-fig. 9). In *Eretmonia*, therefore, the sporangia are also borne on the dichotomising branch system as in *Glossotheca utkalensis* Surange and Maheshwari (Surange & Chandra, 1974).

Discussion — Three species of *Eretmonia* are now known from India. The fertile scale leaf is different in shape and size in different species. It is safe to assume that different species of plants would possess different types of microsporophylls. All of them, however, have almost the same type of venation. There is no well defined mid-

rib, but a number of strong vascular bundles enter from the stalk into the lamina and the outer bundles go on giving out dichotomising and anastomosing scondary veins. Mode of attachment of sporangia in all the three species is the same. The species, therefore, are distinguished at present on the basis of shape and size of the fertile scale leaves.

SPORANGIAL CLUSTERS IN *ERETMONIA*

The fertile leaves of *Eretmonia* are thin at the margin and often show a depression in the middle of the lamina (Text-fig. 11 & 12). Sometimes detached sporangia are also found compressed in the depressed part of the lamina. Du Toit (1932) had also found them in *Eretmonia natalensis* and in fact suspected that the sporangia were actually attached to the lamina. It appears that this type of fertile scale leaf served as protective covering to the sporangial clusters which were borne in its axil. The depression in the lamina might have covered the sporangial clusters and thus offering them protection in young condition. Text-fig. 12 illustrates diagrammatically a side view of the fructification of *Eretmonia* showing



TEXT-FIG. 11 — A reconstruction of *Eretmonia* showing front view. × 4.

TEXT-FIG. 12 — A diagrammatic reconstruction of *Eretmonia* in lateral view showing how the sporangial clusters could be protected in the depression of lamina of fertile scale leaf. × 4.

how the sporangial clusters could have been protected by the fertile scale leaf.

The mode of attachment of sporangia in *Eretmonia* is brought out by different types of branches seen in association with the sporangial clusters in three species of *Eretmonia* described above. In all the species of *Eretmonia* only one pedicel is present. It arises from base of the lamina of the fertile scale leaf and divides into two equal daughter branches, which are almost half in breadth (Text-figs. 6, 7, 10). Each daughter branch carries one sporangial cluster at its apex. The daughter branches then divide higher up by repeated dichotomy and at the same time reducing progressively in size (Text-fig. 11). By measuring the diameter of the pedicel and the ultimate branches, it can be surmised that each daughter branch divides five or six times. The number of sporangia in each cluster must have been normally from 28-32. In actual counting the number did not exceed 32. The last two to three divisions are shown in Text-figs. 8 to 9. The finer dichotomous divisions occur at short distances until fine, ultimate segments bearing sporangia are produced (Text-fig. 9). This is how the pedicel in *Eretmonia* must have divided repeatedly and dichotomously producing a three dimensional branch system which is shown diagrammatically in Text-fig. 10. Thus the sporangia bearing branch system in *Eretmonia* is on the same pattern as in *Glossotheca*. It is, therefore, safe to presume that *Eretmonia* and *Glossotheca* were closely related and both were perhaps related to Glossopteris plants.

REFERENCES

Arber, E. A. N. (1905). The sporangium like organs of *Glossopteris browniana*. Brong. *J. geol. Soc.* **61**: 324-336.

Bharadwaj, D. C. (1962). Miospore genera in the coals of Raniganj Stage (Upper Permian) India. *Palaeobotanist.* **9** (1 & 2): 68-106.

Bharadwaj, D. C. & Salujha, S. K. (1964). Sporological study of seam VIII in Raniganj coalfield, Bihar (India) Part 1. Description of sporae dispersae. *Ibid.* **12** (3): 181-215.

Bose, M. N. & Kar, R. K. (1967). Palaeozoic sporae dispersae from Congo. IV. On some miospore genera *Ann. Mus. r. Afri. Centr. Tervuren in-8° Geol.* **54**: 3-123.

Delevoryas, T. & Gould, R. E. (1971). An unusual fossil fructification from the Jurassic of Oaxaca, Mexico. *Am. J. Bot.* **58** (7): 616-620.

DuToit, A. L. (1932). Some fossil plants from the Karroo system of South Africa. *Ann. S. Afr. Mus.* 27.

Kosanke, R. M. (1950). The Pennsylvanian spores of Illinois and their use in correlation *Bull. Ill. geol. Surv.* **74**: 1-128.

Pant, D. D. & Nautiyal, D. D. (1960). Some seeds and sporangia of Glossopteris flora from Raniganj Coalfield. *Palaeontographica.* **107B**: 42-63.

Potonié, R. & Kremp, G. (1954). Die Gattangen der palaeozoischen sporae dispersae und ihre stratigraphie. *Geol. Jb.* **69**: 111-193.

Salujha, S. K. (1965). Miospore assemblages of seam IX of East Raniganj Coalfield (India). *Palaeobotanist.* **13**(3): 227-238.

Schopf, J. M., Wilson, L. R. & Bentall, Ray (1944). An annotated synopsis of Palaeozoic fossil spores and the definition of generic groups. *Rep. Invest. Ill. St. geol. Surv.* **91**: 1-66.

Sen, J. (1955). On some male fructifications referable to *Glossopteris* and the systematic position of the genus. *Proc. natn. Inst. Sci. India.* **21B** (1): 48-52.

Idem (1956). A new type of male fructification referable to *Glossopteris*. *Nature.* **177**: 337-338.

Surange, K. R. (1957). Studies in the Glossopteris flora of India. 9. A male fructification bearing monolete spores of Glossopteridales from India. *Palaeobotanist.* **6**: 47-48.

Surange, K. R. & Chandra, Shaila (1974). Further observations on *Glossotheca* Surange & Maheshwari A female fructification of Glossopteridales. *Palaeobotanist.* **21**(2): 248-254.

Surange, K. R. & Maheshwari, H. K. (1970). Some male and female fructifications of Glossopteridales from India. *Palaeontographica.* **129B**: 178-191.

EXPLANATION OF PLATES

Plate 1

1. The type specimen of *Kendostrobus cylindricus* gen. et sp. nov. B.S.I.P. no. 19512. Long slender stalk is seen on the left side. × *Ca* 1·5.

2. A part of the specimen shown in Fig. 1 enlarged to show groups of 4-5 sporangia arranged in whorls around a small circular protuberance. × 10.

3. *Eretmonia utkalensis* Surange & Maheshwari. The specimen shows short lamina with an acute apex and a long stalk. Note the pedicel bifurcating into two daughter branches. × *Ca* 2·5.

4. Type specimen of *Eretmonia ovata* sp. nov. B.S.I.P. 35143. Note the sporangial clusters at the bottom left with a long slender branch going under it. × Ca. 2.

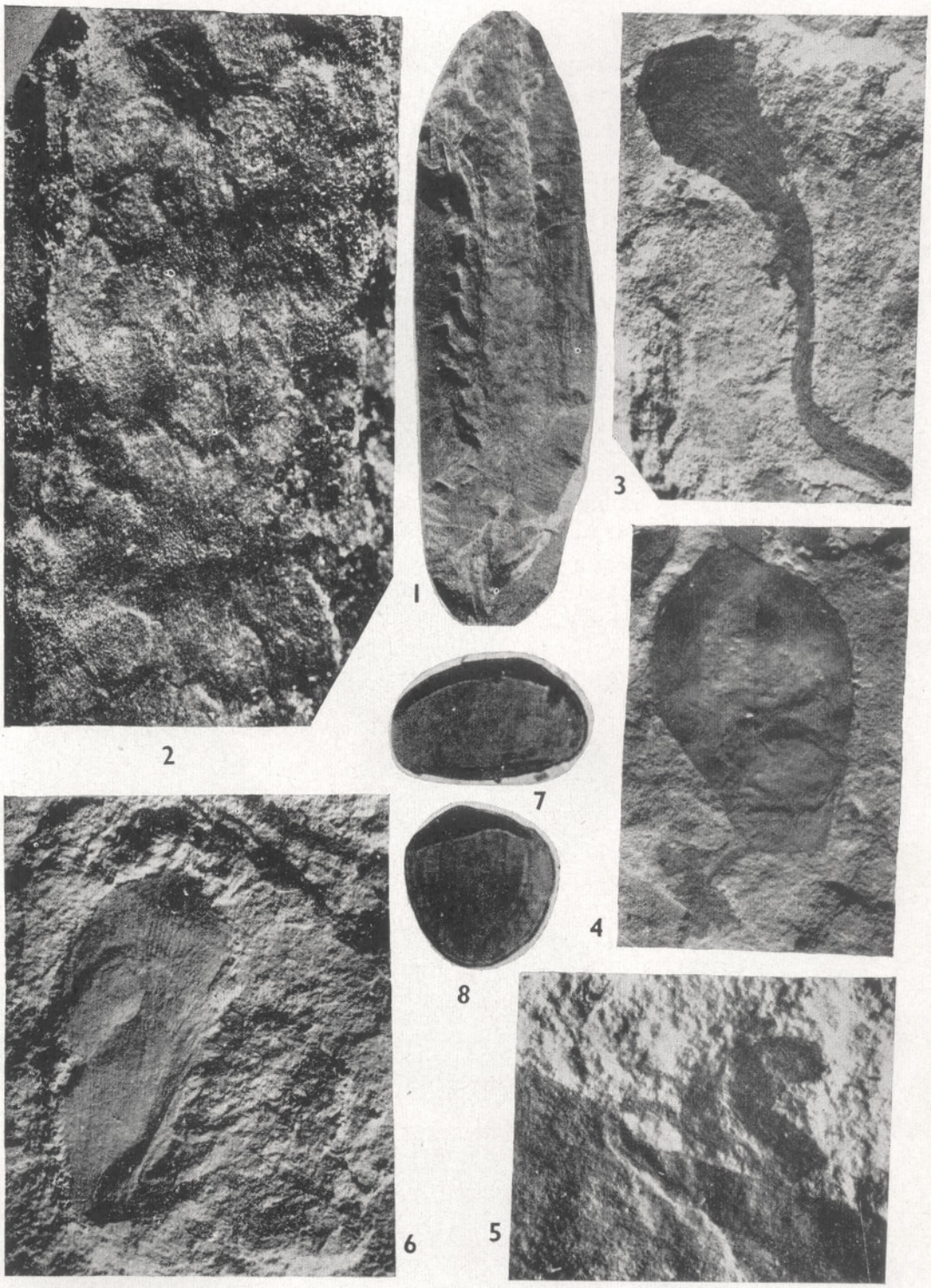
5. Dichotomizing branches of the pedicel of *Eretmonia ovata* sp. nov. × *Ca.* 20.

6. *Eretmonia hinjridaensis* Surange & Maheshwari. Two sporangial clusters are seen lying on the right side of the fertile leaf. × *Ca.* 3.

7-8. Monolete spores from *Kendostrobus cylindricus*. × 400.

PLATE 2

9-25. Spores from *Kendostrobus cylindricus*, showing variations. Figures 9, 12, 13, 14 and 23 s how unmacerated spores with sculptine ridges. × 400.


1
2
3
4
5
6
7
8