

DENKANIA INDICA GEN. ET. SP. NOV.—A GLOSSOPTERIDEAN FRUCTIFICATION FROM THE LOWER GONDWANA OF INDIA

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ABSTRACT

Denkania indica is a female reproductive organ probably of a *Glossopteris* species. It consists of a small, petiolate, linear, fertile leaf with a broad midrib and anastomosing secondary veins. 5, 6 or more cupules, borne on long, slender stalks spring from the basal portion of the leaf. Each cupule contains probably one large seed.

INTRODUCTION

SOME female reproductive organs have been assigned to Glossopteridales in recent years. Plumstead (1952, 1956) in a series of papers described some new genera of reproductive organs. The well known genera are *Scutum*, *Cistella* and *Lanceolatus* which are regarded as the female reproductive organs, bearing seeds. They have been found attached on different species of *Glossopteris*.

Earlier Zeiller (1902) described *Ottokaria bengalensis* which Seward and Sahni (1920) regarded as cupular investment of a seed. Plumstead (1956) regarded *Ottokaria* as related to *Scutum* and borne by *Gangamopteris*. Recently seeds have been recovered from this fructification.

Dictyopteridium (Feistmantel, 1881) is another type of reproductive organ, described as covered with oval to circular scars (Maheshwari, 1965). Surange and Shaila Chandra showed that *Dictyopteridium* is a cone studded with small, naked seeds. *Senothecca* is again a seed bearing organ (Banerjee, 1969) associated with the leaves of *Glossopteris taeniopteroides*. It is a linear fructification with two raised flaps showing faint semicircular markings of seeds. *Lidgettonia* is another fructification from South Africa, bearing stalked cupulate discs bearing seeds or sporangia. Surange and Maheshwari (1970) interpreted the cupulate discs as ovules or seeds in *L. indica*, a new species they described from India.

The fructification described below is different from all those known from the

Palaeozoic of the southern hemisphere. It is, therefore, described under a new generic name.

DESCRIPTION

Denkania gen. nov.

Diagnosis — Female reproductive organ, borne on a fertile leaf; fertile leaf petiolate, small, narrow, linear with acute tip; midrib broad, consisting of a number of parallel veins, secondary veins bifurcating and anastomosing; five, six or more oval cupules borne on long, slender pedicels, pedicels attached at the base of the fertile leaf and on the petiole; oval cupules lobed at their apical ends.

Denkania indica sp. nov.

Diagnosis — Cupulate fructification borne on a fertile leaf; fertile leaf petiolate, narrow, linear, 4.5 to 5 cm. in length; petiole 1 cm. or more long and 2 mm. broad; lamina 4 cm. long and less than 1 cm. broad with acute tip; midrib prominent, broad, persisting up to the apex, consisting of many parallel running veins, secondary veins bifurcating and anastomosing; five or six stalked cupules arise from midrib in basal part of the leaf and upper part of the petiole in a single row, one below the other; pedicels 1 to 1.5 cm. long; cupule oval, 1 cm. long and 6-7 mm. broad, lobed at apical ends.

Holotype — B.S.I.P. No. 35034.

Horizon — Raniganj Stage.

Locality — Handappa, Orissa, India.

We have three specimens in our collection. One complete specimen with its counter part is shown in Pl. 1, figs. 1 & 2 and Text-fig. 1. The other two specimens show detached cupules with broken stalks. All the specimens are preserved as impressions

on light buff coloured, compact shale collected from near Handappa in Orissa.

The entire fertile leaf, including the partly preserved petiole measures 4.5 cm. in length. The lamina, which is broken, is about 4 cm. long; its breadth is not known, but it may be about 8 mm. The leaf is narrow, linear with acute tip. The midrib is prominent, very broad and consists of many strong vascular strands, longitudinally running parallel to one another. The midrib gradually becomes narrow towards the apex, but remains impressively broad, filling almost the entire acute apex. In that portion of the lamina which is preserved at some places, secondary veins are clearly visible. They arise at acute angles from the outer veins of the midrib and immediately bifurcate and unite with one another to form small, narrow meshes. The anastomosing of secondary veins of the fertile leaf is similar to that of a *Glossopteris* leaf.

The cupules are attached by long pedicels at the basal portion of the fertile leaf. The specimen is preserved in such a way that the exact places of attachment of the stalks of cupules are not visible. In the photographs (Pl. 1, Figs. 1, 2) one stalk is seen as if it is attached to the midrib. It can safely be concluded that the stalks of cupules are attached in a row, one below the other, at the base of the leaf, where the midrib is as broad as the petiole with which it merges. Perhaps one or two lower cupules might have been attached quite low down on the petiole, almost in the axillary position. One of the detached cupule is lying almost near the base of the petiole (Pl. 1, Fig. 1). Each cupule has a long, slender stalk or pedicel, 1 cm. to 1.5 cm. in length and 1 mm. in breadth. In some stalks a broad streak is seen running in the middle, which perhaps indicates the position of vascular bundles supplying the cupule. The large cupule is carried almost erect on the stalk and so it must have been provided with a fair amount of strengthening tissue.

The slender stalk at its apex (Pl. 1, Fig. 2) expands into a large cupule which is oval in shape and measures 1 cm. in length and 6-7 mm. in breadth. Most of the cupules are broken at their apical ends, but the one shown in Pl. 2, fig. 4 indicates that the cupule is lobed at its apical end. The number of lobes or the acicular bracts which are fused together at the base, may

be three or more. Cupules appear to be thick. Some cupules give an indication as if one large seed is enclosed in each of them. One such seed seen in Pl. 1, figs. 1, 3 shows remnants of cupule which enclosed it. The seed is large, oval to elongate, 2-3 mm. broad and 3-4 mm. long. The broad integument of the seed might have formed its wing. The nucellus or the central portion of the seed appears to be hard.

RECONSTRUCTION

Text-fig. 2 shows a restoration of *Denkania indica*. When the venation, which is visible only in a small part of the lamina, is repeated in the entire lamina, the leaf looks like a small leaf of *Glossopteris*. The broad midrib continues down into the petiole and almost entirely fills it. The fertile leaf cannot be assigned to any known species of *Glossopteris*. Six cupules are shown attached at the base of the lamina to the "midrib" which continues down into the petiole. The number of cupules is shown as six, but they could be more than six or even less than six in number.

COMPARISON AND DISCUSSION

Denkania indica is unlike any fructification of *Glossopteris* known so far. The midrib and the anastomosing secondary veins of the fertile leaf of *Denkania* makes it look strikingly similar to a sterile leaf of *Glossopteris*. There can, therefore, be hardly any doubt that it is a female fructification of one of the Glossopteridean plant, although it is not necessary that the sterile and fertile leaves of a plant should have the same type of venation pattern.

The female reproductive organs of *Glossopteris* so far known are *Scutum*, *Cistella*, *Dictyopteridium*, *Ottokaria*, *Senotheca* and probably *Lidgettonia*. None of these fructifications, except perhaps *Lidgettonia*, have an organization similar to that of *Denkania*. *Ottokaria*, *Dictyopteridium*, *Scutum*, *Cistella* and *Senotheca*, where naked seeds are studded on a swollen axis, have a cone-like organization. On the other hand *Denkania* is a cupulate organ, like that of Palaeozoic pteridosperms. However, the mode of attachment of *Scutum* and *Cistella* cones and the cupules of *Denkania* to the fertile leaf is strikingly similar; they are attached



TEXT-FIG. 1 — A drawing of holotype of *Denkania indica*. Note the broad midrib and *Glossopteris* type of venation of the fertile leaf. $\times ca 3$.

to the "midrib" of the fertile leaf near its base. In *Denkania* the cupules might have been attached lower down on the petiole itself. The attachment of these reproductive organs to the "midrib" of a leaf is rather unusual, but their attached specimens are rare and are mostly found as poorly pre-

served impressions. It, therefore, becomes very difficult to determine whether the stalks of the fructifications come out of the midrib, or they travel down along the midrib, fused with it or separate from it, right up to the base of the petiole. If the stalks are adnate to the midrib and the



TEXT-FIG. 2 — A restoration of *Denkania indica*. $\times 4$.

petiole, the fructification would then be in effect axillary.

The cupules of *Denkania* resemble in a broad way those of Palaeozoic pteridosperms, particularly those of Lyginopteridaceae. Although anatomical details of *Denkania* cupules are not available, externally at least they are similar to *Lagenospermum* and other Palaeozoic seeds from the northern hemisphere. Functionally also they protect the seed which is situated inside them. However, long stalks of *Denkania* cupules and their mode of attachment to the midrib or the petiole of a fertile leaf appear to be different from other Palaeozoic pteridosperm cupules.

Denkania shows superficial resemblance with the South African genus *Lidgettonia* in the fact that both the fructifications possess cupules. Thomas's *Lidgettonia africana* shows two rows of 4-6 stalked peltate discs containing seeds or sporangia attached to the basal portion of a fertile leaf with no midrib but anastomosing veins. Surange and Maheshwari's *Lidgettonia indica* (1970) has a thick, spatulate, fertile leaf with dichotomising veins but no midrib, from which arises in one row 2-4 short stalks, bearing disc-shaped bodies which were regarded as "seeds". In *Denkania indica*

the fertile leaf is linear, having a broad midrib with dichotomising and anastomosing secondary veins. The fertile leaf of *Denkania indica* is thus quite distinct from that of *Lidgettonia indica* and *L. africana*. Furthermore, the cupules in *D. indica* are large and oval with lobed apical ends, borne on a long slender stalks in one row. It is thus distinct from the south african *Lidgettonia africana*. The seeds or cupules of *Lidgettonia indica*, although borne in a single row, appears to be distinct from the lobed cupules of *Denkania indica* by their shape, size and structure.

RELATIONSHIP

The venation of the fertile leaf of *Denkania indica* is similar to that of a *Glossopteris* leaf. It is necessary that the fertile and sterile leaves of a plant should be similar to each other, on the other hand it may often be just the reverse. However, the shape, the midrib and the venation pattern of the fertile leaf of *Denkania* is so strikingly similar to *Glossopteris* that it can safely be concluded that *Denkania indica* was borne on a plant having *Glossopteris* type of venation. *Denkania* therefore, should be placed under the *Glossopteridales*.

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EXPLANATION OF PLATES

PLATE 1

1. The holotype of *Denkania indica*. B.S.I.P. No. 35034, showing the fertile leaf and five cupules, the sixth cupule lying at the bottom of the photograph. Three cupules are seen with slender stalks, two of which are at the base of the lamina, near the petiole. Broad midrib and the acute tip is clearly visible. The seed on the bottom right is shown enlarged in Fig. 3. ca 4.

2. Counter part of the specimen shown in Fig. 1,

showing the fertile leaf and five cupules borne by it. $\times 2$.

3. The seed from fig. 3 enlarged. Note a part of the cupule adhering to the left side of the seed. $\times 10$.

PLATE 2

4. Two cupules and a part of the fertile leaf enlarged. Note the longitudinally running veins of the midrib. The enlarged cupule near the lamina clearly shows the lobed apex. $\times 10$.



1



3



2



4

B. S. I. P
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