

Some permineralized plant fossils from the Early Cretaceous sediments of Rajmahal Hills, Jharkhand, India

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ABSTRACT

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Some permineralized plant fossils are being described here. These fossils were studied in thin sections of Early Cretaceous cherts collected from Nipania, Amarjola and Chilgajari localities in the Rajmahal Hills, Jharkhand. The plant fossils are assigned to lichens, Marchantiales thallus, lycopodaceous ligule, equisetalean stem sheath, filician rhizomes, gymnosperm seed and *Ptilophyllum* rachis.

Key-words: Permineralized plant fossils, thin sections, Early Cretaceous, Rajmahal Hills, Jharkhand, India.

INTRODUCTION

The Rajmahal Hills, Jharkhand are well known for plant fossils in the form of impressions and petrifications in silicified cherts and a number of papers have been published on the studies of these fossils (Oldham & Morris 1863, Feistmantel 1877, Sahnı 1932, 1948, Srivastava 1945, Vishnu-Mittre 1953, 1959, Sharma 1967, 1970, 2014, Bose 1968, Bose et al. 1984, 1985, Banerji 2000, Sharma et al. 2001, 2006, 2010, etc.). The localities in the northern portion of the area, e.g. Dhokuti, Sakarigalighat, Onthea, etc. yielded fossils as impressions whereas those in the southern portion, e.g. Mundro, Sonajori, Nipania, Amarjola, Chilgajari, etc.

yielded petrifications (Gupta 1966, Verma & Sharma 2013). The plant fossils described here are lichens, Marchantiales thallus, lycopodaceous ligule, equisetalean stem sheath, filician rhizomes, gymnosperm seed with an undulating integument and rachis of bennettitalean leaf *Ptilophyllum*.

MATERIAL AND METHOD

The permineralized material was collected from Nipania, Amarjola and Chilgajari in Amarapura region. The Amarjola material required cooking in Canada balsam prior to sectioning with a wire bandsaw, whereas hard silicified cherts were cut by a diamond edge wheel.

Slides were prepared by the usual method of cutting, grinding and polishing techniques and mounted in dilute canada balsam. Description of plant fossils is based on the study of thin sections and hand specimens of cherts.

DESCRIPTION AND DISCUSSION

Lichen type A: Occurrence of this fossil lichen in the Rajmahal Hills was reported for the first time by Sharma et al. (2001). It was seen in a thin section prepared of Nipania chert. It is a cross section of an oval shaped structure bearing many scattered globular algal bodies, each having a cavity.

Lichen type B: It has irregular but united cup shaped bodies (Plate 1 figure A, Text-figure 1). Each cup encloses a large number of blackish, globular structures representing algal constituent of the lichen. The fungal hyphae make the bodies of the united cups. It looks like a pyrenocarpous type of lichen with numerous algal bodies.

Lichen type C: It is a vertical section of an apothecium like structure (Plate 1, figures B-C, Text-figure 2) consisting of hair like paraphysis and intermingled, compactly arranged asci (Text-figure 2). However, ascospores are not preserved nicely. In the lower basal portion of apothecium, many blackish globular algal bodies are present.

Marchantiales thallus: A cross section of Marchantiales thallus is seen in a thin section prepared of the Chilgajari chert (Plate 1, figure D, Text-figure 3). It has a flat upper surface with little upward curvatures at the terminal ends. The upper surface has closely arranged brick like cells (Plate 1, figure D-arrow). The lower surface is angular without differentiation of surface cells. The central tissue is many cells thick with irregularly scattered small cavities and black globular bodies of unknown nature and function. It may be young sporophyte identical to that of *Riccia* like plant (Text-figure 3). This is the first report of a petrified bryophytic plant from the Rajmahal Hills.

Lycopodiaceous ligule: Ligule is a special structure in heterosporous lycopods, viz. *Selaginella*, *Isoetes*, *Stylites* and many fossil forms (Sharma & Singh 1984, Pant et al. 2000, Sharma & Purohit 2011). It is attached on the basal adaxial portion of the leaf. Its

presence has also been recorded in a few homosporous fossil lycopods, viz. *Leclirequia*. Vice versa in a heterosporous lycopods, *Bisporangioctrobus harrisii* Chitale and McGregor (1988), the ligule is absent. The ligule has a basal embedded portion called as glossopodium (Sharma & Singh 1984). In the present material (a thin section of Chilgajari chert), there is seen a long, thin, multicellular ligule (L) originating from a large kidney shaped multicellular glossopodium (g) (Plate 1, figures E-F, Text-figures 4-5) identical in morphology and anatomy to that of *Isoetes* sp. (Pant et al. 2000). Interestingly, glossopodia with ligules are visible only on the long narrow, vascularised stem whereas the associated leaves are either not preserved or they were absent (Plate 1, figures E, G, Text-figure 4). This is the first report of a lycopodiaceous ligule like structure from the Rajmahal Hills.

Equisetaceous stem sheath: Similar to the extant taxon *Equisetum*, its extinct form *Equisetites* also had nodes and internodes, and the latter had ridges and furrows. At each node, there was a sheath consisted of many scales which were united at the basal portion. It is believed that the present material (Plate 1, figure H) is a cross section through the basal united portion of stem scales. It is seen in a slide prepared of the Chilgajari chert. The outer surface has ridges and furrows while inner face has a thick smooth layer. In the furrow portions, the outer epidermis is distinct and is made up of squarish thick walled cells (Plate 1, figure H-arrow). In some of the ridges, cavities are visible which may be a distinct character or an ill preservation of the tissue.

Ophioglossaceous rhizome: This specimen was collected from Nipania chert. The cross section is more or less circular with a well developed fleshy parenchymatous ground tissue (Plate 1, figure I). In the central portion, there are four bundles in a quadrant and surrounding them are three patches of three bundles each (Text-figure 6). All the 13 bundles are more or less identical in construction. Each bundle has a distinct bundle sheath and a large unpreserved portion, on the inner side of which are preserved few cells of xylem (Plate 1, figure I, Text-figure 7). The outer three patches of bundles are probably traces of trophophylls or vascular supply to the fertile branches in a cone comparable to

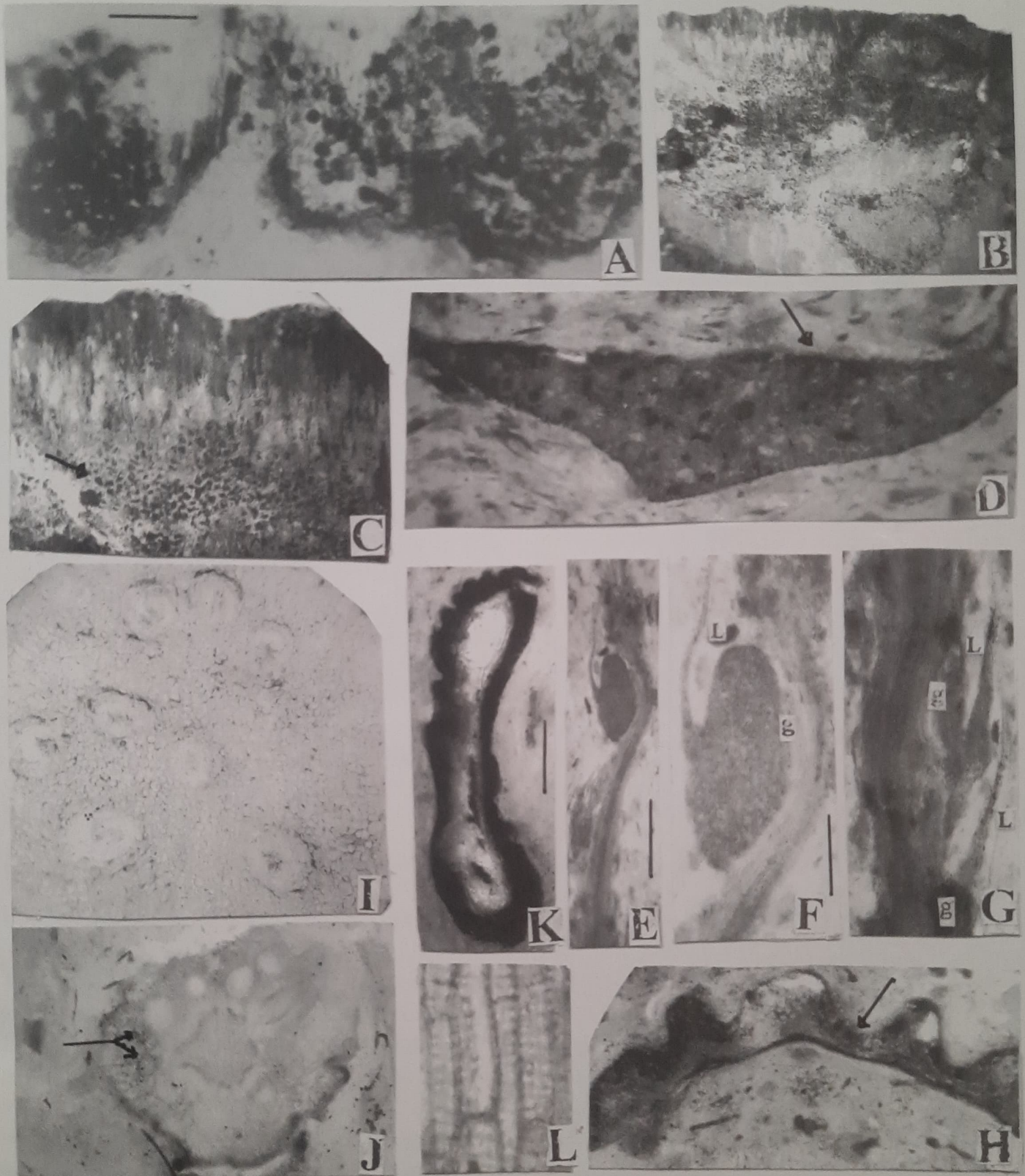
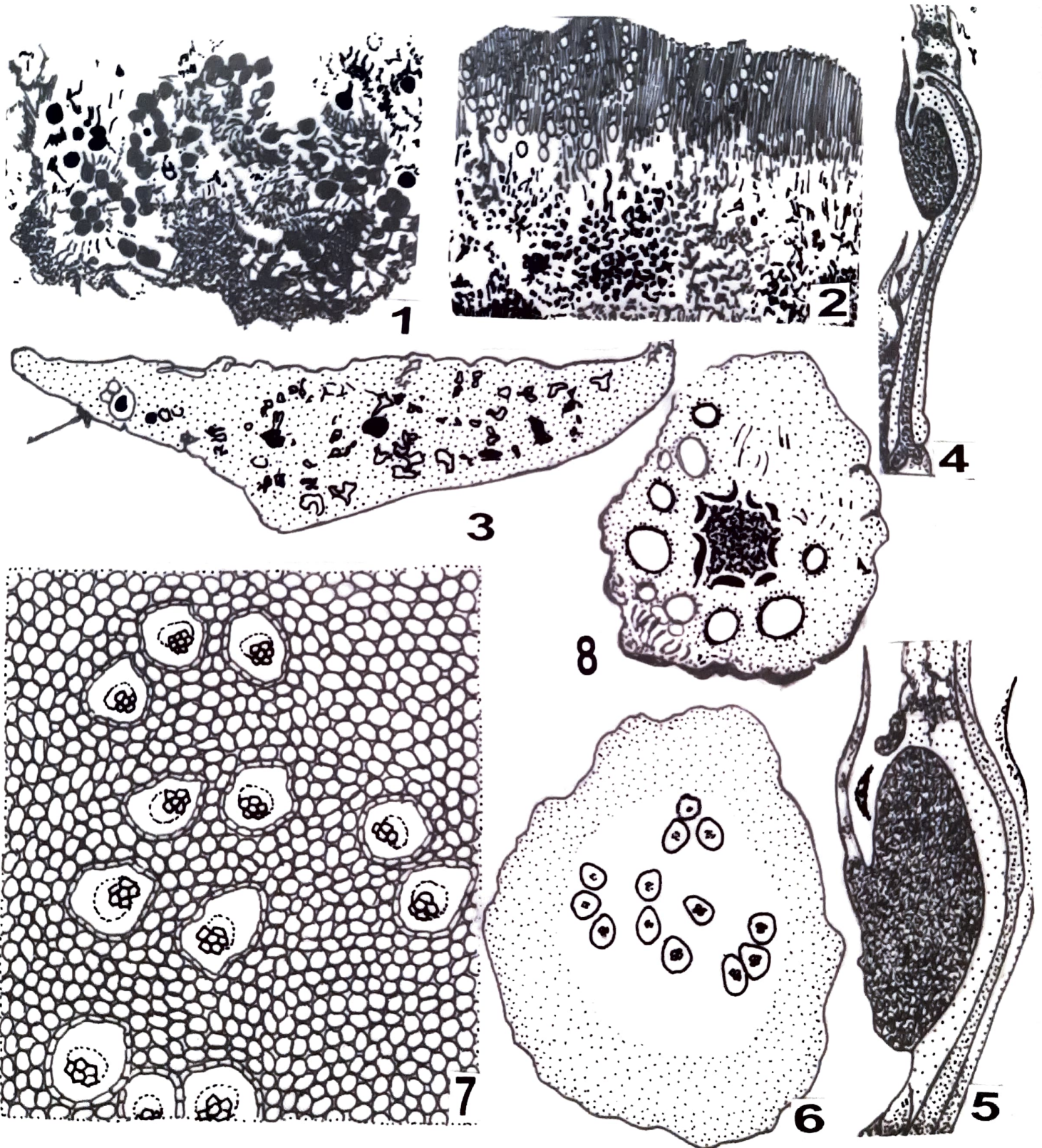


Plate 1

A. Lichen type B, united irregular cup like bodies with black globular algal bodies. B. Vertical section of an apothecium. C. Same enlarged, black globular perithecia present in the basal portion of an apothecium. D. Cross section of a Marchantiales thallus. Note brick shaped upper surface cells (arrow). E. A narrow vascularised plant with an embedded glossopodium (g) and narrow ligule (L). F. Same enlarged. G. Same, plant portion with two ligules. H. Equisetaceous stem sheath with ridges and furrows, distinct cells are seen in the furrows (arrow). I. An ophioglossaceous rhizome. ground tissue parenchymatous with four central bundles and the peripheral ones in groups of three. J. C.S. of fern rhizome with unpreserved circular bundles and the central pith are visible. K. C.S. of gymnosperm flat seed. L. *Ptilophyllum* rachis, L.S. of ground tissue with rectangular cells and 1-3 rows of simple pits. (Bar: B, E, K = 80 μ m, A, C, D, F-J, L = 36 μ m).



Text-figures 1-8. 1. Lichen type B, united irregular cup like bodies containing black globular algal bodies. 2. Lichen type C, V.S. of an apothecium, upper portion has paraphysis and asci while the lower one contains algal bodies. 3. C.S. of thallus of Marchantiales with cavities and probably sporophytes (black bodies) (arrow). 4. L.S. of kidney shaped glossopodium and a whip like ligule in a lycopodiaceous plant. 5. Same enlarged. 6. Ophioglossaceous rhizome with well developed ground tissue and the vascular bundles. 7. Same enlarged, ground cells and the bundles. 8. Fern rhizome, C.S. Pith sclerenchymatous, bundles unpreserved and in a ring, double leaf trace bundles. (Bar: 4, 6 = 75 μ m, 1-3, 5, 8 = 35 μ m, 7 = 20 μ m).

that of *Helminthostachys zeylanica* (Bierhort 1971, Figure 11-8 N). Fossils of ophioglossaceous plants are rare in literature (Taylor et al. 2009). Rothwell and Stockey (1989) and Rothwell (1996) reported impression of *Botrychium* like fronds from the Palaeocene of Canada. Spores of Ophioglossales are well known from the Jurassic and Early Cretaceous sediments. However, permineralized material of this order is unknown and therefore the present material is the first report of petrification of an Ophioglossales.

Fern rhizome: Petrifications of a number of fern rhizomes are known from the Rajmahal Hills (Sharma et al. 2013). Vishnu-Mittre (1959) described two species of *Solenostelopteris* (Schizaeaceae) from the Nipania locality on the basis of anatomy of the rhizomes, i.e. solenostelic vasculature. The present material also comes from the Nipania chert but it does not have solenostelic vasculature. It is a cross section with little irregular outline due to the presence of leaf bases (Plate 1, figure J, Text-figure 8). The periphery has thick walled cells and an originating double trace in the cortical portion. The pith is angular and has thick walled cells. The bundles are many (8-10) in a ring surrounding the pith. These are circular, unpreserved and show little variations in size. In gross morphology, this cross section resembles with that of the rhizome of *Adiantum capillus-veneris* (Singh et al. 1984).

Gymnosperm seed: Suthar et al. (1988) described a number of isolated seeds belonging to Podocarpaceae, Taxaceae and Araucariaceae from the Sonajori cherts. The present seed is seen in a section cut of a piece of Chilgulari chert. It is a cross-section of a flattish seed with a thick dark coloured integument (Plate 1, figure K). At places, the outer face of integument is undulating. Cellular details are not preserved. The inner integument is thin and adhered to the outer one. Nucellus etc. portions of the seed are unpreserved and therefore its taxonomic position is not clear. No such seed has been described from the Rajmahal Hills so far.

***Ptilophyllum* rachis:** *Ptilophyllum* is the most commonly occurring bennettitalean frond in the flora of Rajmahal Hills. Anatomy of its rachis was studied by Sharma (1967) and Rao and Achuthan (1968). The

rachis has a well developed, parenchymatous ground tissue surrounding the double U shaped vascular zone, which consists of many collateral and conjoint bundles, with xylem facing each other of the two rows. The present material is a longisection of the rachis collected from Amarjola. The rectangular cells of the ground tissue have 1-3 rows of simple pits (Plate 1, figure L), a character not described earlier in *Ptilophyllum*. Greguss (1969) described presence of similar pits on the ground tissue cells of the stems of living cycads and compared them with the transfusion cells.

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