Taeniopteroid leaves from Lower Gondwana formations of India

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ABSTRACT


Well preserved leaves discovered from the Early Permian sequence of Barakar Formation of Pench Valley Coalfield, Satpura Gondwana Basin demonstrate the earliest occurrence of taeniopteroid leaves in Lower Gondwana formations. Such leaves are mostly recorded from the Late Permian sequence of Raniganj Formation and assigned to different genera, Taeniopteris Brongniart, Macrotaeniopteris Schimper and Rhabdotaenia Pant.

The review of all the known records, the examination of type and figured specimens and present study indicate that plausibly all the taeniopteroid leaves of Lower Gondwana belong to the genus Rhabdotaenia Pant (1958) and the species, Rhabdotaenia danaeoides (Royle) Pant, Rhabdotaenia harkini Pant and Rhabdotaenia fibrosa Pant are characterized by large sized leaves whereas new species Rhabdotaenia pantii sp. nov. is instituted for small size-obovate shaped leaves discovered from the New Sethia open cast mine of Pench Valley Coalfield, Madhya Pradesh.

Key-words—Taeniopteroid leaves, Lower Gondwana, Rhabdotaenia, New Species.

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INTRODUCTION

TAENIOPTEROID leaves are scarcely documented in the Lower Gondwana formations of India. Royle 1839 for the first time described such leaves under the genus *Glossopteris* as *G. danaeoides* but Mc Clelland (1850) transferred the form to *Taeniopteris* Brongniart. In 1869 Schimper instituted a new genus *Macrotaeniopteris* to include the large size leaves with distant secondary nerves, accordingly Feistmantel (1876, 1880, 1886) described Lower Gondwana taeniopteroid leaves under the species of *Macrotaeniopteris*, i.e. *M. feddeni* Feistmantel and *M. danaeoides* (Royle) Feistmantel. Arber (1905) strongly opposed the institution of the genus *Macrotaeniopteris* only on the basis of large size leaves and similar views were also expressed by Nathorst (1878), White (1893), Seward (1894) and Zeiller (1902).

Later discovery proved that leaves of *Taeniopteris*-type are distributed in different geologic horizons of Palaeozoic and Mesozoic and in all likeness *Taeniopteris* represents the complex group with varied morphology, cuticular features and fertile structures. The taeniopteroid leaves with syndetocheilic stomata are assigned to *Nilssoniopteris* of Bennettitales whereas anatomical features of taeniopteroid leaves of Pentoxyylon are identified as *Nipaniophyllum*, haplocheilic stomata associated with the taeniopteroid leaves are known as of *Bjuvea* Florin 1933 and *Doratophyllum* Harris 1932. Similarly, different types of fertile forms, *Phasmatocycas*, *Spermopteris*, *Archaeocycas*, etc. have also been found to be associated with taeniopteroid type of leaves (see Taylor et al., 2009, p. 683). Bose and Banerji (1981) have referred morphologically similar leaves of *Taeniopteris* known from Jurassic and Lower Cretaceous rocks of India to Cycadophyceae.

In view of complexity of taeniopteroid leaves, Pant (1958) examined the morphological and cuticular features of taeniopteroid leaves discovered from Glossopteris flora of East Africa and also examined the Lower Gondwana leaves described from India by Royle (1839) and Feistmantel (1876, 1880, 1886). Pant

![Geological map of Pench Valley Coalfield showing the location of fossil locality (modified after Singh & Shukla, 2004).](image)
(1958) observed a similarity in cuticular characters of taeniopteroid leaves of Glossopteris flora with the leaves of Glossopteris and proposed a new genus Rhabdotaenia for earlier described taeniopteroid leaves of Lower Gondwana under Macrotaeniopteris by Feistmantel (1876, 1882, 1886). Pant and Verma (1963) made a detailed study of such leaves, instituted a new species Rhabdotaenisa fibrosa and described the additional characters of R. danaeoides. Pant & Verma (1963) emphasized that "the general form and epidermal structure of Rhabdotaenia are nevertheless comparable with those of Glossopteris, Gangamopteris and Palaeovittaria and it is quite likely that Rhabdotaenia too will ultimately prove to belong to a plant of the same alliance." Later Pant (1962, 1982, 1987), Surange (1966, 1975), Chandra (1974a, b) and Srivastava (1991, 1998) considered Rhabdotaenia as one of the ally of the leaf of the genus Glossopteris Brongniart 1828.

Palaeobotanical investigation of Lower Gondwana sediments of Satpura Gondwana Basin has yielded a well preserved specimens of Rhabdotaenia. The leaves characterized by small size, obovate shape are described under a new species Rhabdotaenia pantii sp. nov.

**SAMPLE LOCATION AND GEOLOGICAL SETTING**

Satpura Gondwana Basin situated in between 22°06' and 22°28' N latitude 77°48' and 78°53' E longitude is the major coal producing area in the central India. There are three major coalfields, Pench Valley, Kanhan Valley and Pathakhera (Tawa) in the basin. Western Coalfields Limited, subsidiary of Coal India Limited is responsible for the exploitation of coal and each coalfield is divided into number of areas and sub areas (Srivastava & Agnihotri, 2009, 2010).

Pench Valley Coalfield (78°38'-79° and latitude 22°09'-22°24') is known after the river Pench and extends over the length of about 32 km from Sukri in the west to Haranbata in east (Fig. 1). Coal occurs in a thick sequence (250 m) of Barakar Formation and there are three major and two local coal seams in the area.

The plant fossils have been recovered from New Sethia open cast mine (78°50'44" E: 22°12'49" N) situated in the Shivpuri area of Pench Valley Coalfield about 7 km east of Parasia Town of Chhindwara District, Madhya Pradesh. The Barakar Sequence is...
marked by 12 m thick sequence and it is underlain by 32 m thick Motur beds. The coal seam belongs to upper seam showing three splits marked as A, B and C in the lithocolumn (Fig. 2). The plant fossil assemblage has been recovered from the grey sand stones and carbonaceous shales.

The fossils are preserved as impression on grey to white sand stone and carbonaceous shales. Well preserved complete leaf impressions of *Rhabdotaenia* are collected along with the specimens of different species of *Cyclodendron, Glossopteris, Gangamopteris, Euryphyllum, Noeggerathiopsis, Vertebraria* and number of dispersed seeds of *Samaropsis* and *Cordaicarpus* types (Srivastava & Agnihotri, 2010).

**SYSTEMATICS**

**Genus**—RHABDOTAENIA Pant 1958

**Type species**—*Rhabdotaenia danaeoides* (Royle) Pant 1958

*Rhabdotaenia pantii* sp. nov.

(Pl. 1.1-6)

*Diagnosis*—Leaf small (maximum 4.4 x 2.3 cm), obovate, petiolate, midrib distinct, thick, striated; lamina arises from the sides of midrib, widest in upper region, lamina narrower towards base, apex obtuse, sometimes apiculate, base broadly cuneate; lateral veins arise from midrib at 75°-80°, run parallel, after little bend reach the margin of leaf, dichotomize once or twice but never anastomose.

*Holotype*—BSIP Museum Specimen No. 39845A & B with part and counterpart.

*Horizon & Age*—Barakar Formation, Lower Gondwana, Early Permian.

*Locality*—New Sethia open cast mine, Pench Valley Coalfield, Satpura Gondwana Basin, Chhindwara District, Madhya Pradesh.

*Repository*—Museum, Birbal Sahni Institute of Palaeobotany, Lucknow, India.

*Derivation of Specific Name*—The species is named after Prof D.D. Pant, renowned palaeobotanist who instituted the genus *Rhabdotaenia*.

*Description*—There are 12 leaf impressions in the collection. The complete leaf is preserved with part and counterpart. The shape of the leaves are typically obovate but smaller leaf shows oblong shape. The size ranges from 2.1 to 4.4 cm in length and 1.0-2.5 cm in width, being the widest in upper part of leaf. The apex is broadly obtuse, complete leaf indicates apiculate nature but its extreme part is not well defined. Base of the leaf is contracted and broadly cuneate in nature. Midrib is thick, 0.5-1.5 mm broad, narrower towards apex and possesses fine striations. The petiolate nature of leaf of well defined and it is 5-7 mm in length and 1-2 mm thick. Margin of the leaf is entire and apparent concavity is visible. Lateral veins arise from the midrib at 75°-80° (never at 90°), curved, bend upward and after slight arching reach the margin of leaf. Lateral veins forked once or twice near the point of origin or in middle course of lamina. They never anastomose. Concentration of veins is 14-20 near midrib and 19-23 near margin in the lower part and 12-18 near midrib and 19-25 near the margin in the upper part of the leaf.

One of the specimens shows 3-4 leaves in attachment with very thin axis measuring 1-2 mm in width and possesses fine striations (Pl. 1.6). The obovate shape leaves are quite small (1-2 cm long and 0.4-0.8 cm long) and possess venation pattern similar to *R. pantii* sp. nov. Apparently specimen indicates that the leaves are attached at the terminal portion of the axis by their long petiole (6-10 mm long).

**COMPARISON AND DISCUSSION**

The present leaves compare with the leaf of the genus *Rhabdotaenia* Pant 1958 instituted to accommodate the taeniopteroid leaves from Lower Gondwana formations. The morphological and cuticular features of such leaves are closely related with the leaves of Glossopteridales (Pant, 1982) and classified as Glossopteridales without mesh forms along with the leaves of *Rubidgea, Euryphyllum* and *Palaeovittaria* whereas Glossopteridales with mesh forms are
1, 2. *Rhabdotenia pantii* sp. nov. Holotype, part and counter part showing obovate shape petiolate leaf with lateral veins arise from the midrib at 75°-80°, curved, bend upward and after slight arching reach the margin of leaf. BSIP Museum Specimen No. 39845 A & B.

3, 4. Two obovate shape leaves of *R. pantii* sp. nov. showing venation pattern similar with the Holotype. BSIP Museum Specimen No. 39846, 39847.

5. Small obovate shape leaf of *R. pantii* sp. nov. showing long petiole. BSIP Museum Specimen No. 39848.

6. Three-four small size leaves of *R. pantii* sp. nov. showing distinct venation pattern attached to terminal part of thin axis with their long petiole. BSIP Museum Specimen No. 39849.
represented by the leaves of *Gangamopteris* and *Glossopteris* (Srivastava, 1991).

The venation pattern of *Rhabdotaenia* is also comparable with *Pterophyllum burdwanense* but both the genera are distinct in having dissected margin of leaves (Feistmantel, 1886; Seward & Sahni, 1920). New species *R. pantii* sp. nov. is distinct from all the known species of *Rhabdotaenia*, *R. danaeoides* (Royle) Pant 1958, *R. harkini* Pant 1958 and *R. fibrosa* Pant & Verma 1963 in having distinct shape and venation pattern. *R. pantii* sp. nov. is small size obovate shape leaves where lateral veins emerge at less than 90° and bend upward, curve and arch before reaching the margin of leaves. Whereas *R. danaeoides*, *R. harkini* and *R. fibrosa* are represented by large size oval, oblong to broad shape leaves (more than 10 cm long and more than 4 cm wide) where lateral veins emerge at acute angle and run straight at 90 and parallel to each other. *R. fibrosa* is further distinguishes from *R. pantii* sp. nov. in possessing fibres in between lateral veins (Pant & Verma, 1963).

Feistmantel (1882) also instituted a species *Macrotaeniopteris feddeni* which Pant (1958) considered as similar to *R. danaeoides* but our observation of the type specimens of *Macrotaeniopteris feddeni* described by Feistmantel (1882, 1886) preserved in the Museum of Geological Survey of India vide Specimen No. 5203, 1882, Pl. 22 fig. 1, Specimen No. 5205, 1882, Pl. 22, fig. 3, Specimen No. 5206, 1882, Pl. 22 fig. 4 and Specimen No. 5498, 1886, Pl. 4, fig. 1 strongly suggests that as observed by Feistmantel (1882) lateral veins “are closely set, dichotomous; almost horizontal in the lower portion of the leaves, becoming more oblique towards the apex; but in both cases the veins are somewhat turned upwards near the margin.” As such the species is distinct from *M. danaeoides*. However, *M. feddeni* Feistmantel (1882, 1886) are represented by the fragments of different portions of the leaves and none of the leaf is complete. Therefore transfer of *M. feddeni* to *Rhabdotaenia* is avoided till the discovery of better preserved leaf. Singh et al. (2006) described a leaf under *Macrotaeniopteris feddeni* Feistmantel from Talchir Coalfield, Mahanadi Basin, Orissa, however, as described by authors the secondary veins emerge from the midrib at 15°-20° whereas secondary veins in original leaves of *M. feddeni* of Feistmantel (1882, Pl. 22, figs 21-25; 1886, Pl. 4, fig. 1) emerge at 90°. The examination of the leaf described by Singh et al. (2006, Pl. 2, fig. 1) clearly indicates anastomosing of secondary veins forming meshes near the midrib and also in between the midrib and margin of leaf. The leaf is similar with *Glossopteris* and shows resemblance with the species *G. arberi* Srivastava (Chandra & Surange, 1979).

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