

Taeniopteroid leaves from Lower Gondwana formations of India

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ABSTRACT

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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.

भारत की निम्न गोंडवाना शैलसमूहों से प्राप्त टीनियोप्टिरोयड पर्ण

ए.के. श्रीवास्तव एवं दीपा अग्निहोत्री

सारांश

सतपुड़ा गोंडवाना द्रोणी के पेंच घाटी कोयला क्षेत्र के बराकार शैलसमूह की प्रारंभिक पर्मियन अनुक्रम से खोजी गई सुपरिदक्षित पर्णों को निम्न गोंडवाना शैलसमूहों में टीनियोप्टिरोयड पर्णों की प्रारंभिक उपस्थिति प्रदर्शित की जाती है। ऐसी पर्ण रानीगंज शैलसमूह की अंतिम पर्मियन अनुक्रम से अधिकतर अभिलिखित की गई हैं तथा विभिन्न वंशों *टीनियोप्टेरिस* ब्रोंगनियार्ट, *मैक्रोटीनियोप्टेरिस* स्किम्पर तथा *रहाडोटीनिया* पंत को प्रदान की गई हैं।

सभी पहचाने अभिलेखों का अवलोकन, प्ररूप एवं आकृति युक्त प्रतिदर्शों की जांच तथा वर्तमान अध्ययन से इंगित होता है कि *रहाडोटीनिया* पंत (1958) वंश तथा *रहाडोटीनिया दानेओयडिज* (रॉयल) पंत, *रहाडोटीनिया हर्किनी* पंत तथा *रहाडोटीनिया फाइब्रोसा* पंत प्रजातियों से संबंधित निम्न गोंडवाना की सत्याभासी सभी टीनियोप्टिरोयड पर्ण बड़े आकार की पत्तियों से लक्षणित हैं जबकि *रहाडोटीनिया पंतयाई* नव प्रजाति को मध्य प्रदेश के पेंच घाटी कोयला क्षेत्र की नयी सेठिया खुली कोयला खान से खोजी गई छोटे आकार-प्रतिअंडाकार आकार हेतु संस्थापित की गई है।

संकेत-शब्द—टीनियोप्टिरोयड पर्ण, निम्न गोंडवाना, *रहाडोटीनिया*, नवप्रजाति।

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 Bennetitales whereas anatomical features of taeniopteroid leaves of Pentoxylon 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 Cycadophyte.

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

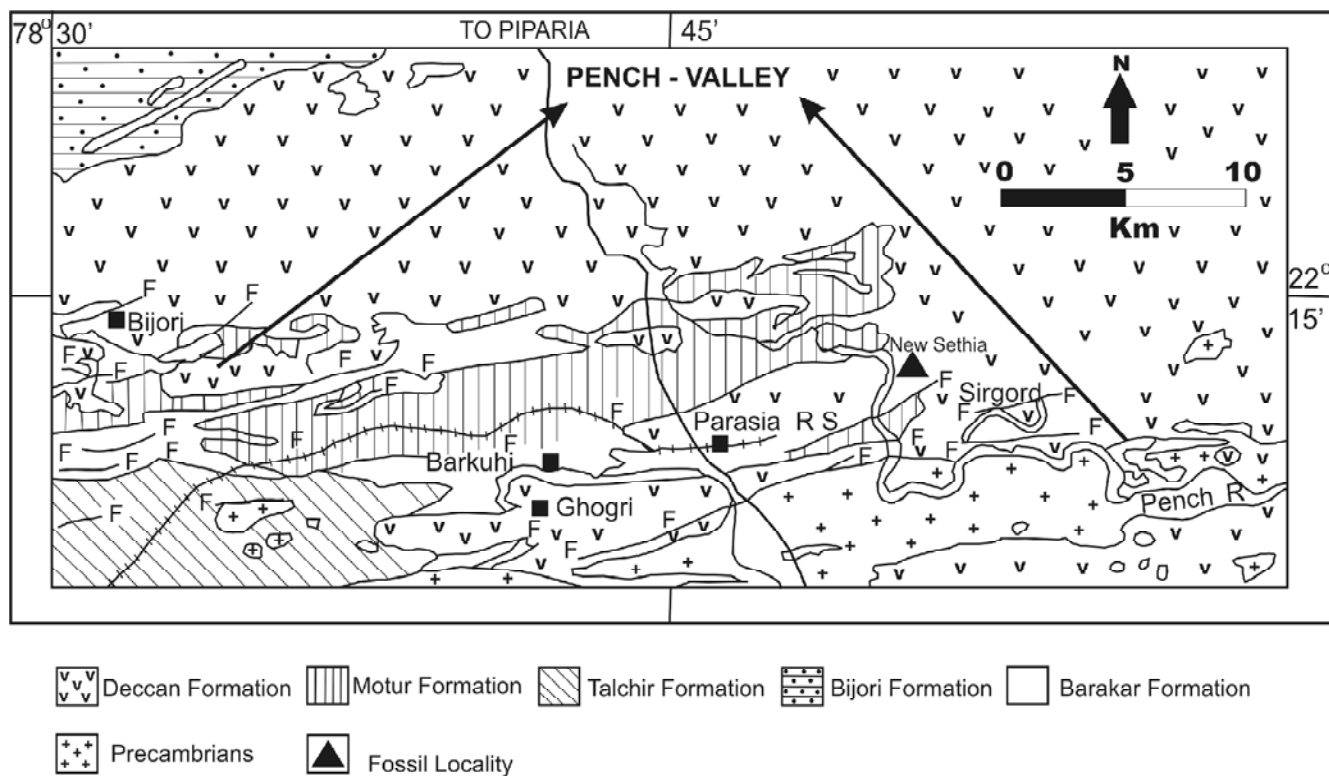


Fig. 1—Geological map of Pench Valley Coalfield showing the location of fossil locality (modified after Singh & Shukla, 2004).

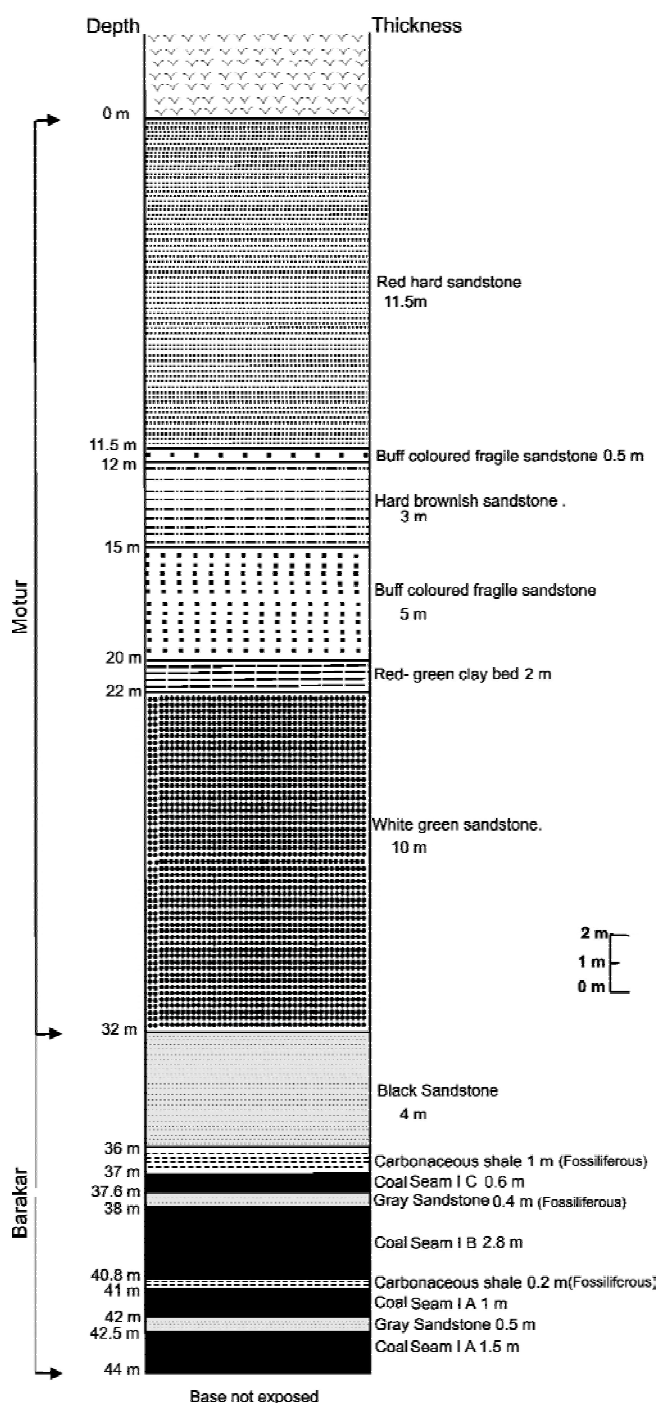


Fig. 2—Lithological succession of New Sethia open cast mine.

(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 Pathakhhera (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 is 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

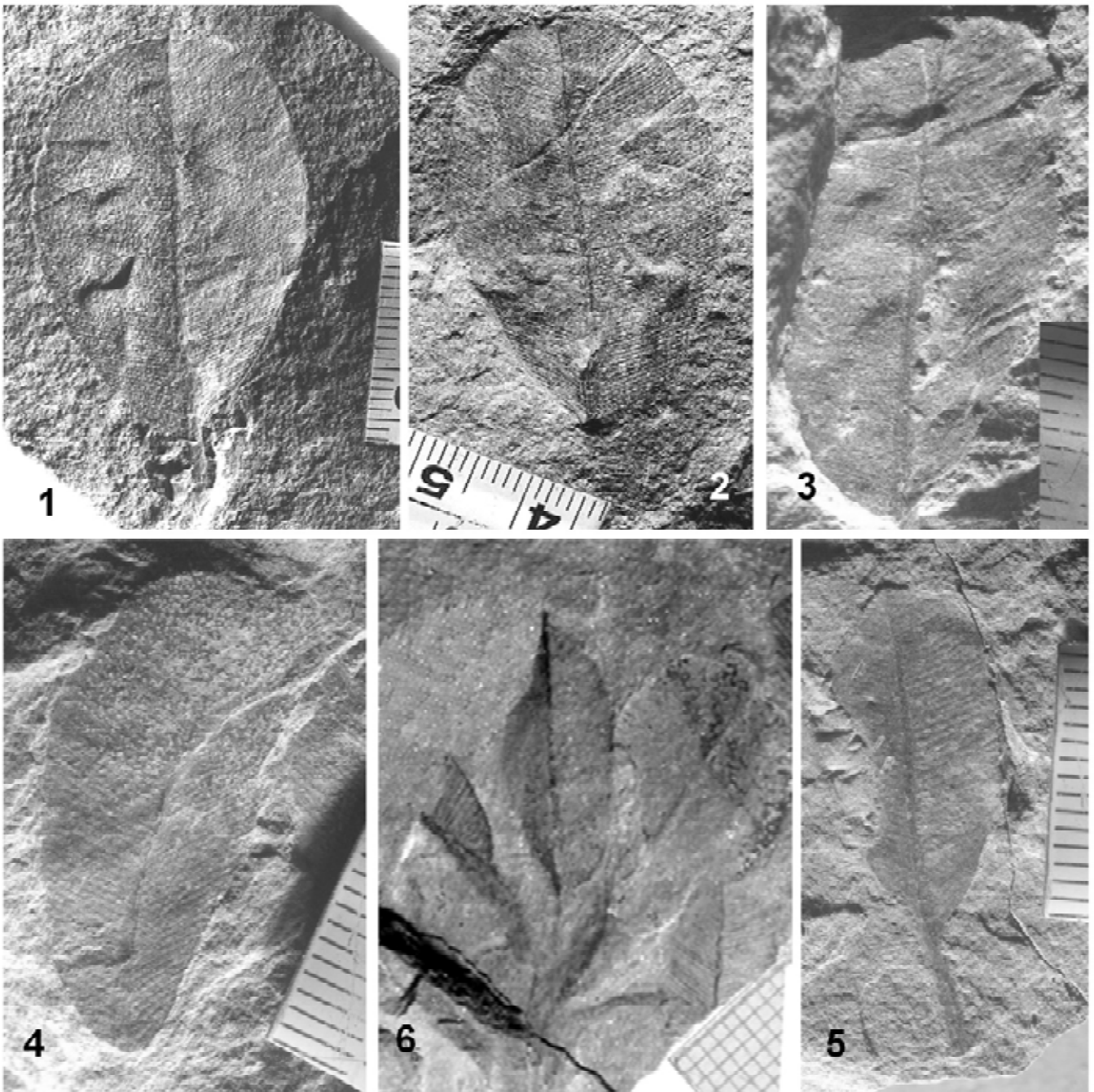


PLATE 1
(Bar = 1 mm)

- 1,2. *Rhabdotaenia 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 *Pseudoctenis balli* and *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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