

Occurrence of *Vertebraria indica* (Unger) Feistmantel, 1877 – an evidence for coal-forming vegetation in Kothagudem area, Godavari Graben, Telangana

First record of *Vertebraria* Royle ex McCoy (1847) from the lower part of the Barakar Formation of Goutham Khani Open Cast Mine, Kothagudem area, Godavari Graben is documented here. Considering the rare records of plant megafossils from the Godavari Graben, occurrence of *Vertebraria* in abundance, in the early Permian sediments of Goutham Khani, Kothagudem is significant, as it indicates the presence of *Glossopteris* flora that was responsible for the formation of thick coal seams in the area. The term *Vertebraria* was first coined by Royle¹. He published a table mentioning the name of two species of the genus – *Vertebraria indica* and *V. radiata*, which were recorded from the Raniganj Formation of Raniganj Coalfield, Damodar Basin, West Bengal, India. The species were created on the basis of the mode of their horizontal and vertical preservation respectively. However, no diagnosis or description of the species was provided. Royle provided illustrations of *Vertebraria indica* and *V. radiata* which could have validated the genus according to the ICN² article 42.3, and article 38.1 of an earlier edition of the *International Code of Botanical Nomenclature*³ which states that ‘In order to be validly published, a name of a new taxon of fossil plants of specific or lower rank published on or after 1 January 1912 must be accompanied by an illustration or figure showing the essential characters, in addition to the description or diagnosis, or by a reference to a previously and effectively published illustration or figure.’ However, since no description or diagnosis was provided by Royle¹, the year of the valid publication of the genus *Vertebraria* is considered as 1847 by McCoy (in Doweld⁴). Doweld⁴ discussed in detail the nomenclatural status of *Vertebraria* and mentioned ‘Searching extensively through post-1834 literature, both geological and botanical, we could not find any other work in which *Vertebraria* as a genus has been validly published except for that of McCoy (l.c.) who for the first time provided a distinct generic description, and description of a new species *Vertebraria australis* (serving as type of

the generic name) from stratigraphically similar deposits in Australia [type specimens now in the Sedgwick Museum of Earth Sciences, Cambridge]. Therefore, *Vertebraria* Royle ex McCoy has been validated on Australian material, not Indian, and the type of the generic name may not be listed as “*Vertebraria indica* Royle” (Rigby & al. in *Geol. Surv. Queensland Publ.*, 1980, **348**, 16; McLoughlin & al. in *Antarct. Sci.*, 2005, **17**, 71)’. Accordingly, the Indian form *Vertebraria indica* is now reinstated as *Vertebraria indica* (Unger) Feistmantel⁵.

According to Arber⁶, *Vertebraria indica* and *V. radiata* are similar, but preserved in different modes. Surange and Maheshwari⁷ reported two other species *V. raniganjensis* and *V. myelonis* on the basis of anatomical study, mainly considering the nature of pits and the presence of pith in vascular bundles respectively. *V. raniganjensis* was considered by Schopf⁸ as identical to *V. indica* on the basis of anatomical characters. Earlier workers^{9–15} regarded *Vertebraria* as stem, rhizome or root of *Glossopteris* because of its occurrence in dispersed condition along with the *Glossopteris* leaves. Schopf^{8,16,17}, Gould¹⁸ and Neish *et al.*¹⁹ have confirmed the root nature of *Vertebraria*. On the basis of *in situ* preservation^{20–22}, it was further established that *Vertebraria* is a root. The genus has been recorded from all the Lower Gondwana formations such as Talchir, Karharbari, Barakar, Barren Measures, Raniganj, Kamthi and Bijori (Kamthi and Bijori are considered younger than Raniganj Formation²³) from different basins of India, namely, Damodar, South Rewa, Satpura, Wardha, Godavari, Mahanadi and Rajmahal^{24–26} (Figure 1). An analysis of Figure 1 reveals that the genus was well distributed both horizontally and vertically in India. Additionally, the genus is known from the early Permian Mamal Formation of Kashmir, Bhareli and Khelong formations, Khuppi Village, Kameng district, Arunachal Pradesh, Western Garo Hills, Meghalaya and Pankabari-Darjeeling, West Bengal from the Himalayan region^{27,28}. Recently, Bhowmik and Parveen²⁹ reported a new

species of *Vertebraria* namely, *V. nidpurensis* from Triassic of Nidpur.

Sporadic plant megafossils are known from lower part of the Barakar Formation of Godavari Graben^{30–33}. The sole record of *Vertebraria* is from the Chintalpudi sub-basin^{30,31}. In the present communication, the genus *Vertebraria* is reported for the first time from the Goutham Khani Open Cast Mine, Kothagudem area, Godavari Graben, Telangana.

The Godavari Valley Coalfield covers an area of about 17,000 sq. km bounded by 16°38'N and 19°32'N lat. and 79°12'E and 81°39'E long. The coalfield has an average width of 55 km, though there is a well-defined constriction in the Paluncha–Kothagudem area where it is only 6 km wide. The coal seams of economic value are mainly confined to the Godavari and Kothagudem sub-basin and the Yellandu outlier. The Kothagudem belt stretches for about 18 km from Kothagudem in the north, up to Pengadapa in the south. The Singareni Collieries Company Limited, has established the following sequence³⁴

| | |
|---------------------|---------------|
| Top (queen) seam | 6.7 to 13.5 m |
| Parting | 42 m |
| King seam | 2.1 to 31.3 m |
| Parting | 0.91 to 6.3 m |
| Bottom (green) seam | 4.2 to 8.4 m |

Only the King Seam is of economic importance. It is 2.1 m in the Birly pit in the northern end of the belt and progressively increases to 31.3 m in the Goutham Khani mining block in the south. There are three collieries namely Goutham Khani, Venkatesh Khani and Padmawati Khani in the Kothagudem area of which Goutham Khani (Figure 2a) is an Open Cast Mine, whereas, Venkatesh Khani and Padmawati Khani are underground mines. Two workable coal seams occur within the mine boundary. An index seam about 3 m thick exists over the top seam and consists of 30 cm thick coal band alternating with carbonaceous shale above and below. The gap between top seam and index seam is 60 m (Figure 2b). The mine is spread over a distance of up to 2.30 km

| FORMATION NAME OF BASINS/ COALFIELDS | DAMODAR | | | | | | | SOUTH REWA | | | | SATPURA | WARDHA | GODAVARI | MAHANADI | RAJMAHAL | | | | |
|--|---------|--------|----------|---------|----------|------------|-------|-------------|------------------|---------|----------|------------------|--------------|---------------|------------------------------------|----------|---------|-----------|----------|-----------|
| | Giridih | Jharia | Raniganj | Auranga | Karapura | Daltonganj | Hutar | West Bokaro | Ramkola-Tatapani | Shahpur | Sobagpur | Birsinghpur-Pali | Pench-Valley | Wardha Valley | Goutham Khani OCP, Kothagudem area | Hingir | Talchir | Singrauli | Ib-River | Pachhware |
| KAMTHI | | | | | | | | | | | | | + | | | | | | + | |
| BIJORI | | | | | | | | | | | | + | | | | | | + | | |
| RANIGANJ | | + | + | | + | + | | | + | + | + | | | | | | + | + | | |
| BARAKAR | + | + | | | + | + | | | | | + | + | | | + | * | | | | + |
| KARHARBARI | + | | | | | | + | | | | | | | | | | | | | |
| TALCHIR | | | | | | | | | | | | | | | | | | | | |

*Present study

Figure 1. Distribution of *Vertebraria indica* in Lower Gondwana horizons of India.

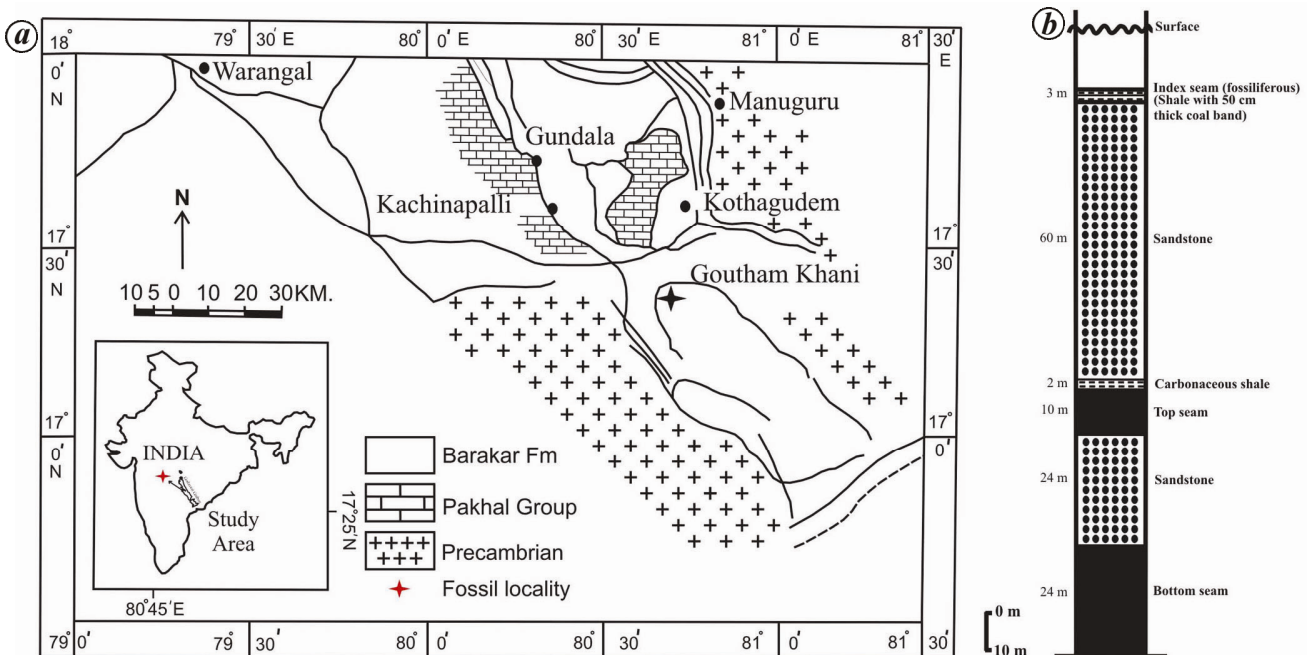


Figure 2. a, Geological map showing fossil locality. b, Litholog of Goutham Khani Open Cast Mine, Kothagudem area (after SCCL, Kothagudem area).



Figure 3. *Vertebraria indica* (Unger) Feistmantel 1877. **a**, Specimen BSIP 40194. **b**, Specimen BSIP 40195. **c**, Specimen BSIP 40196. **d**, Specimen BSIP 40197 (scale bar = 1 cm).

in NE and SW direction and up to 1.30 km along NW and SE direction.

Thirty specimens of *Vertebraria* were collected from the carbonaceous shale of the index seam (3 m thick) of Goutham Khani Open Cast Mine, Kothagudem area (Figure 2 b). The specimens are preserved as impressions and were studied with the help of a hand lens and low power binocular microscope Leica DFC 290 under incident light for morphotaxonomical characters. All the specimens are deposited in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow vide statement no. 1355.

Division – Gymnosperms

Order – Glossopteridales

Genus – *Vertebraria* Royle ex Mc Coy, 1847

Type species – *Vertebraria australis* Mc Coy, 1847

Vertebraria indica (Unger) Feistmantel, 1877

Description: The specimens are incomplete, horizontally preserved, unbranched axes, measuring 1–16 cm in length and 0.4–3.5 cm in width, consisting of 3 to 20 unequal rectangular areas measuring 0.4–3.0 × 0.3–1.4 cm in size, arranged in two linear rows and separated by 2–4 mm wide median grooves, a longitudinal median ridge is present between the rows.

The specimens compare in their morphological features with *Vertebraria indica* (Pl. 15, fig. 3, Pl. 16, figs 4 and 18 in Doweld⁴), Pant and Singh¹² (Pl. 124, figs 2–5), Srivastava²¹ (Pl. 1, figs 3, 4

and 9), Srivastava and Agnihotri²³ (Pl. 4, fig. 3), Srivastava²⁷ (Pl. 4, fig. 6), Tewari and Srivastava²⁸ (Pl. 2, fig. 9), Goswami³⁵ (fig. 3c).

Records of megafossils from Godavari Graben are rare. Other than the genus *Vertebraria*, no plant megafossils were found in the Goutham Khani Open Cast Mine. Considering the paucity of plant fossils from the Godavari Graben, the occurrence of *Vertebraria* in abundance in the Goutham Khani Open Cast Mine is noteworthy, since it confirms the presence of *Glossopteris* flora which was responsible for the formation of coal in the area.

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ACKNOWLEDGEMENTS. We thank Prof. Sunil Bajpai, Director, Birbal Sahni Institute of Palaeobotany for providing necessary facilities; to Mr K. Joshuva Jaidev, GM (Exploration), Exploration Division, Mr K. Ravi Shankar, General Manager (HRD), Mr Gurumurthy, Singareni Collieries Company Ltd. Kothagudem, for granting permission to visit the colliery and for providing necessary help during field trip, and Mr Shekhar, Area Survey Officer, Manuguru area, Kothagudem region, for help in preparation of litholog and in plant fossil collection. We also thank the two unknown reviewers for critically reading the manuscript and providing constructive suggestions.

Received 4 February 2014; revised accepted 15 October 2014

ARUN JOSHI^{1,2,*}
 RAJNI TEWARI¹
 DEEPA AGNIHOTRI¹
 S. S. K. PILLAI¹
 R. K. JAIN²

¹Birbal Sahni Institute of Palaeobotany,
 53, University Road,
 Lucknow 226 007, India
²D.A.V. (P.G.) College,
 Dehradun 248 001, India
 *For correspondence.
 e-mail: arunjoshi119@gmail.com