Palaeobotanist 49 (2000) 23-30
0031-0174/2000/23-30 $2.00

Plant fossil assemblage from the Talchir Formation, Auranga Coalfield, Bihar, India

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(Received 03 August 1999; revised version accepted 07 February 2000)

ABSTRACT

Tewari R & Srivastava AK 2000. Plant fossil assemblage from the Talchir Formation, Auranga Coalfield, Bihar, India. Palaeobotanist 49(1) : 23-30.

Investigations on the Talchir sediments of Auranga Coalfield have yielded well preserved plant fossils from Jaitri river section situated about 1·5 km northeast of Latehar town of Palamau District, Bihar. The assemblage is represented by the species of *Gangamopteris* (*G. cyclopteroides, G. fibrosa, G. clarkeana, G. major, G. angustifolia, G. karharbariensis, Gangamopteris* sp.) and *Glossopteris* (*G. talchirensis, G. indica, G. communis, G. stenoneura, G. tenuifolia, G. spatulata*) besides a number of scale leaves and equisetalean-stem axes. The known records of plant fossils from theTalchir Formation indicate dominance of *Gangamopteris* leaves (10 sp.) whereas, *Glossopteris* leaves are recorded by only two species. The present report of occurrence of six species of *Glossopteris* and seven species of *Gangamopteris* demonstrates simultaneous settlement and diversification of the two types of glossopterid leaves i.e., midrib- less forms of *Gangamopteris* and midrib possessing forms of *Glossopteris*, during the early phase (the Talchir Formation) of Glossopteris flora.

Key-words— Talchir Formation, *Glossopteris, Gangamopteris*, Auranga Coalfield, India.

बिहार के औरंगा कोयला क्षेत्र के तालचीर शैलसमूह से प्राप्त पादपाश्म समुच्चय

रजनी तिवारी एवं अश्विनी कुमार श्रीवास्तव

सारांश

औरंगा कोयला क्षेत्र के तालचीर अवसादों के विश्लेषण से पलामू जनपद के लातेहार कस्बे से 1·5 कि.मी. दूर उत्तर-पूर्व में स्थित जैत्री नदी परिच्छेद से सुसंरक्षित पादपाश्म प्राप्त हुए हैं. समुच्चय में अनेक शल्क पत्रों तथा इक्वीसिटेलियन तना अक्ष के अतिरिक्त *गैंगामॉप्टेरिस* (*जी. साइक्लॉप्टीरायड्स, जी. फाइब्रोसा, जी. क्लर्कियाना, जी. अंगुस्टीफोलिया, जी. करहरबारिएन्सिस, गैंगामॉप्टेरिस* प्रजाति) एवं *ग्लॉसोप्टेरिस* (*जी. तलचीरेन्सिस, जी. इण्डिका, जी. कम्यूनिस, जी. स्टीनोन्यूरा, जी. टेन्यूईफोलिया, जी. स्पेट्यूलेटा*) की प्रजातियाँ हैं. तालचीर शैलसमूह से ज्ञात अभिलेखों से *गैंगामॉप्टेरिस* की पत्तियों (10 प्रजातियाँ) की प्रमुखता का संकेत मिलता है, जबकि *ग्लॉसोप्टेरिस* की पत्तियाँ मात्र दो प्रजातियों द्वारा अभिलेखित की गई हैं .*गैंगामॉप्टेरिस* की 7 प्रजातियों तथा *ग्लॉसोप्टेरिस* की 6 प्रजातियों की प्रमुखता सम्बन्धी वर्तमान रिपोर्ट से प्रारंभिक अवस्था अर्थात *ग्लॉसोप्टेरिस* वनस्पतिजात के तालचीर शैलसमूह के दौरान *गैंगामॉप्टेरिस* के मध्य शिरा विहीन रूप तथा *ग्लॉसोप्टेरिस* के मध्यशिरा युक्त रूप की दो प्रकार की ग्लॉसोप्टेरिड पत्तियों के युगपत् बन्दोबस्त एवं विविधरूपण प्रदर्शित हुए हैं.

संकेत शब्द—तालचीर शैलसमूह, *ग्लॉसोप्टेरिस, गैंगामॉप्टेरिस,* औरंगा कोयला क्षेत्र, भारत.

INTRODUCTION

PLANT fossils from the Lower Gondwana succession of Auranga Coalfield are well known from the Karharbari, Barakar and Raniganj formations (Feistmantel, 1881; Bhattacharyya, 1959; Bhattacharyya, 1963; Srivastava, 1977a, b, 1978, 1979, 1996; Srivastava & Tewari, 1996). In comparison, the Talchir Formation is poorly known by its fossil contents. Feistmantel (1881), for the first time reported equisetaceous stalks, *Gangamopteris cyclopteroides, G. cyclopteroides* var. *subauriculata, G. cyclopteroides* var. *acuminata, G. cyclopteroides* var. *attenuata, G. cyclopteroides* var. *cordifolia, G. spatulata, Noeggerathiopsis hislopii* and winged seeds of *Samaropsis* from Talchir shales of Latehar hill. Fragmentary leaf impressions and equisetaceous stems were reported by Bhattacharyya (1963) from Deogarh Reserve Forest.

Present assemblage for the first time reports the presence of seven species of *Gangamopteris* and six species of *Glossopteris* in the Talchir Formation of India.

The Talchir Formation, representing the lower most sequence of Gondwana comprises the earliest representatives of Glossopteris flora in India. Plant fossils from this formation are known from South Rewa Gondwana Basin (Ganguly, 1959; Surange & Lele, 1957; Chandra & Srivastava, 1982; Chandra *et al.*, 1992) Giridih Coalfield (Surange & Lele, 1956), Rikba beds of North Karanpura Coalfield, Auranga Coalfield (Feistmantel, 1881) and Singrauli Coalfield (Lele *et al.*, 1968). Recently, Chandra and Singh (1996), while describing the assemblage from the type locality of the Talchir Formation i.e. Talchir Coalfield, have provided a list of all the known records. Records of bryophytic remains from Talchir beds of South Rewa Gondwana Basin (Chandra 1995) have added new dimensions towards the knowledge of Talchir flora.

Floristic analysis of Talchir Formation indicates presence of 10 species of *Gangamopteris*, two species of *Glossopteris* and one species each of *Ottokaria, Arberia, Paranocladus, Noeggerathiopsis, Samaropsis, Cordaicarpus* and *Vertebraria*. First record of *Gangamopteris fibrosa, G. karharbariensis, Glossopteris stenoneura, G. tenuifolia, G. spatulata* alongwith, earlier reported species of *Gangamopteris* and *Glossopteris* in the Talchir Formation of Auranga Coalfield is indicative of the variety and richness of Glossopteris flora in its early stage.

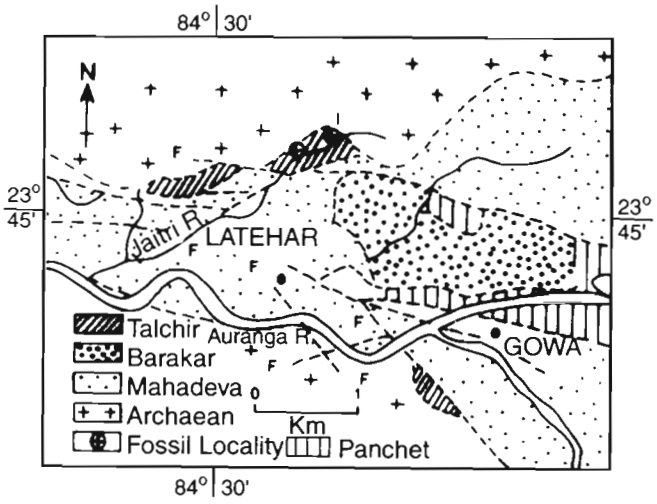

Fig. 1 — Geological map of the area showing fossil locality.

MATERIAL AND METHODS

Specimens were collected from the Talchir beds exposed in Jaitri River, a small tributary of Auranga River, situated about 1·5 km north-east of Latehar Town, Palamau District, Bihar (Fig. 1). Geology and stratigraphic sequence of the area are discussed by Raja Rao (1987) in detail. Plant fossils are preserved as impressions in brownish yellow Talchir needle shales and sandstones. Identification of the species is based on external morphological features i.e. shape, size and venation pattern. Since the flora is represented by the known species of *Gangamopteris* and *Glossopteris*, only a brief description and comparison is provided along with photographs. All the type and figured specimens are preserved in the museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

PLATE 1

1 *Glossopteris tenuifolia* Pant & Gupta, middle portion of linear-lanceolate leaf showing long, narrow meshes. Specimen no. BSIP 38333. x 2.

2 *Gangamopteris major* Feistmantel, an almost complete spathulate leaf showing obtuse apex, narrow base, median subparallel anastomosing veins forming secondary veins with elongate, narrow meshes. Specimen no. BSIP 38334. x 3.

3. *Glossopteris stenoneura* Feistmantel, an incomplete leaf showing obtuse apex, flat, striated, evanescent midrib and arched, thin, dense secondary veins with narrow, trapezoidal, elongate meshes. Specimen no. BSIP 38335. x 2.

4 & 6. *Glossopteris indica* Schimper, incomplete portions of lanceolate leaves showing acute apex, persistent midrib, arched secondary veins forming trapezoidal meshes, which are short and broad near midrib and narrower near margin. Specimen no. BSIP 38336c. x 2 and 38338. x 1.

5. *Gangamopteris cyclopteroides* Feistmantel, an incomplete leaf showing tapering base, prominent subparallel median veins forming long, trapezoidal narrow meshes. Specimen no. BSIP 38336b. x 1.

7. *Gangamopteris fibrosa* McCoy, an incomplete leaf showing median subparallel veins and arched, flexuous secondary veins forming elongate, polygonal meshes. Specimen no. BSIP 38339. x 2.

8. *Gangamopteris angustifolia* McCoy, an incomplete linear leaf showing middle part with median subparallel veins and arched secondary veins with trapezoidal meshes. Specimen no. BSIP 38340. x 2.

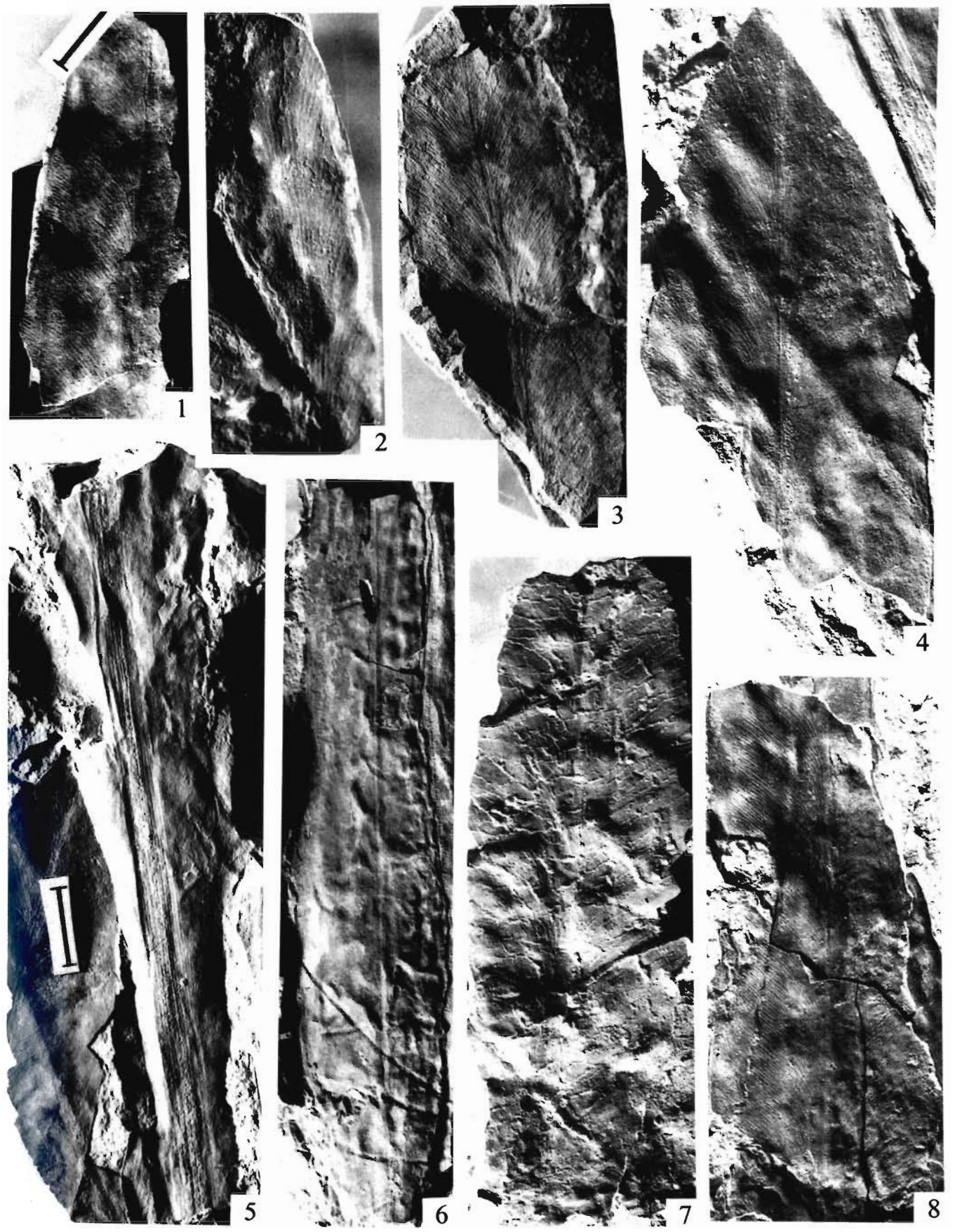

PLATE 1

SYSTEMATICS

Genus—GANGAMOPTERIS McCoy, 1847

GANGAMOPTERIS CYCLOPTEROIDES Feistmantel, 1876

Pl. 1·5

Complete leaf is not preserved; different portions of leaves ranging in size from 4·1-14 cm in length and 1·8-2·5 cm in width are preserved; apex not preserved, base narrow, tapering; median region occupied by a group of subparallel veins, prominent at base, forming meshes; secondary veins arise from these at acute angles, curve backwards to meet margin and after anastomosing and dichotomising, form long and broad meshes near median veins and narrow meshes towards margin.

Comparison—The leaves described here compare well with *G. cyclopteroides* (Feistmantel, 1879; Maithy, 1965).

Number of specimens—Six.

GANGAMOPTERIS FIBROSA Maithy, 1965

Pl. 1·7

Leaf incomplete, measures 8·7 cm in length and 2·7 cm in width, shape? lanceolate, apex not preserved, base tapering, median subparallel veins distinct, with anastomoses; secondary veins arise at acute angles from median veins, follow a flexuous course to meet margin and after anastomosing and dichotomising, form elongate, polygonal meshes with characteristic subparallel, flexuous, elongate fibres.

Comparison—The venation pattern of the leaf is similar to *G. fibrosa* (Maithy, 1965).

Number of specimen—One.

GANGAMOPTERIS CLARKEANA Feistmantel, 1890

Pl. 2·5

Complete leaf is not preserved, only basal portions of leaves ranging from 4·6-6·6 cm in length and 3·6-4·0 cm in width are preserved; base narrow; thick median subparallel veins radiate from the basal region, bifurcate and form oblong meshes; secondary veins arise from median veins, arch backwards to meet margin and after dichotomising and anastomosing form elongate, narrow, trapezoidal meshes.

Comparison—The leaves are similar to *G. clarkeana* (Feistmantel, 1879; Maithy, 1965).

Number of specimens—Two.

GANGAMOPTERIS MAJOR Feistmantel, 1879

Pl. 1·2

Leaf measures 2·9 cm in length and 1·9 cm in width; shape spathulate, apex obtuse, base narrow, median region occupied by few subparallel veins; secondary veins arise from median veins, curve backwards to meet margin and after anastomosing and dichotomising form elongate, narrow meshes.

Comparison—The leaf is comparable to *G. major* (Feistmantel 1879; Maithy, 1965).

Number of specimen—One.

GANGAMOPTERIS KARHARBARIENSIS Maithy, 1965

Pl. 2·4

Leaf incomplete, only middle part is preserved which measures 4·8 cm in length and 2·8 cm in width, base narrow; median region occupied by few weak subparallel veins with anastomoses; secondary veins arise from median veins at acute angles, curve backwards to meet margin and after anastomoses and dichotomization, form narrow, elongate meshes of uniform size.

Comparison—The leaf compares well with *G. karharbariensis* (Maithy, 1965). However, epidermis in this leaf is not preserved.

Number of specimen—One.

GANGAMOPTERIS ANGUSTIFOLIA McCoy, 1847

Pl. 1·8

PLATE 2

1 *Glossopteris talchirensis* Chandra & Surange, an incomplete leaf showing middle and basal parts, with a distinct, elevated, striated midrib and arched secondary veins forming polygonal meshes. Specimen no. BSIP 38341. x 1.5.

2. *Glossopteris spatulata* Pant & Singh, an incomplete leaf showing middle portion, persistent, thin midrib, slightly curved secondary veins with narrow, elongate, meshes which are smaller and narrower towards margin. Specimen no. BSIP 38342. x 1.5.

3. *Gangamopteris* sp., an incomplete specimen showing few weak subparallel veins with anastomoses, slightly arched secondary veins and elongate meshes. Specimen no. BSIP 38343. x 2.

4. *Gangamopteris karharbariensis* Maithy, an incomplete leaf showing narrow base, median region with few subparallel veins and arched secondary veins. Specimen no. BSIP 38344. x 2.

5. *Gangamopteris clarkeana* Feistmantel, an incomplete leaf showing middle and narrow basal part, thick median subparallel veins radiating from basal region and arched secondary veins with elongate, narrow, trapezoidal meshes. Specimen no. BSIP 38345. x 1.3.

6. *Glossopteris communis* Feistmantel, an incomplete leaf showing middle part, striated midrib and dense venation with elongate, narrow meshes Specimen no. BSIP 38346 x 1.

7. *Glossopteris tenuifolia* Pant & Gupta, an incomplete leaf showing acute apex, persistent, thin midrib and arched secondary veins with long narrow meshes.. Specimen no. BSIP 38347. x 1.3.

8. Scale leaf, showing ovate shape, acute apex, cuneate base and venation pattern. Specimen no. BSIP 38337B. x 1.5.

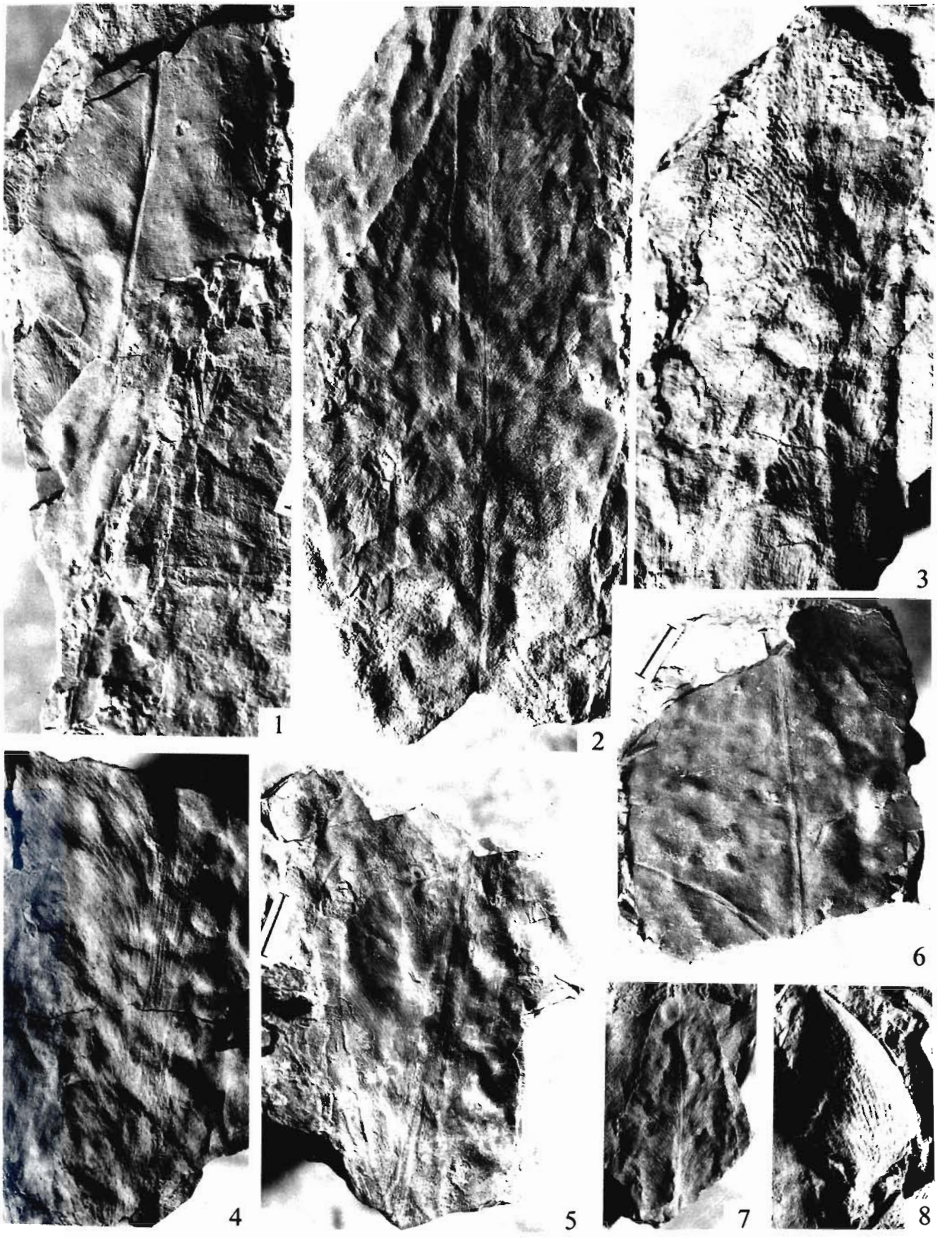

PLATE 2

Complete leaf is not preserved; middle portion of leaf measuring 9 cm in length and 3 cm in width is preserved; shape linear, median region occupied by few subparallel veins with meshes; secondary veins arise from median veins at acute angles, curve backwards to meet margin and after anastomosing and dichotomising, form narrow, elongate, hexagonal to trapezoidal meshes.

Comparison—The leaf is comparable with *G. angustifolia* (Feistmantel, 1879; Maithy, 1965) in shape and venation pattern.

Number of specimen—One.

GANGAMOPTERIS sp.

Pl. 2·3

Complete leaf not preserved; middle portion of leaf measuring 6·0 cm in length and 2·3 cm in width is preserved; median region occupied by few, thin subparallel veins with anastomoses; secondary veins arise from these at acute angles, curve slightly backwards to meet margin and after anastomosing and dichotomising, form elongate meshes which are slightly narrow near margins.

Number of specimen—One.

Genus—GLOSSOPTERIS Brongniart, 1828

GLOSSOPTERIS COMMUNIS Feistmantel, 1876

Pl. 2·6

Complete leaf is not preserved, different portions of leaves ranging in size from 4·0-9·0 cm in length and 3·0-6·9 cm in width are preserved; apex obtuse, base acute-cuneate; midrib 1·5-3·5 mm wide, striated; secondary veins arise at an acute angle, curve backwards to meet margin and after anastomising and dichotomising, form narrow-elongate meshes throughout the lamina.

Comparison—The leaves are comparable with *G. communis* (Feistmantel, 1879; Chandra & Surange, 1979).

Number of specimens—Ten.

GLOSSOPTERIS INDICA Schimper, 1869

Pl. 1·4, 6

Leaves incomplete; measure 2·5-15·5 cm in length and 2-3 cm in width; shape lanceolate, apex acute, base acute-cuneate; midrib 0·5-2·0 mm wide, solid, elevated, strong, striated, thinning in apical region; secondary veins dense, arise at acute angles, curve backwards to meet margin, and after anastomosing and dichotomising, form short, trapezoidal meshes, broader near midrib, narrower near margins.

Comparison—The venation pattern of the leaves is comparable with *G. indica* (Chandra & Surange, 1979).

Number of specimens—Eight.

GLOSSOPTERIS TALCHIRENSIS Chandra & Surange, 1979

Pl. 2·1

Leaf incomplete, middle portion of leaf is preserved which measures 5·1 cm in length and 3 cm in width; midrib 1 mm wide, distinct, elevated, striated; secondary veins arise at an acute angle, meet margin straight or curve slightly and after anastomosing and dichotomising, form medium, polygonal meshes which are broader near midrib and narrower near margin where they are more closely spaced.

Comparison—The leaves are comparable with *G. talchirensis* (Chandra & Surange, 1979).

Number of specimen—One.

GLOSSOPTERIS STENONEURA Feistmantel, 1877

Pl. 1·3

Complete leaf is not preserved, different portions of leaves ranging in size from 3·0-5·5 cm in length and 1·6-3·0 cm in width are preserved; shape spathulate, apex obtuse, base narrow, midrib 1-2 mm wide, flat, striated, evanescent; secondary veins arise at acute angles, curve backwards to meet margin and after anastomosing and dichotomising, form trapezoidal, narrow, elongate meshes, venation dense.

Comparison—The leaves are comparable with *G. stenoneura* (Chandra & Surange, 1979; Tewari & Srivastava, 1996) in shape and venation pattern.

Number of specimens—Twelve.

GLOSSOPTERIS TENUIFOLIA Pant & Gupta, 1968

Pl. 1·1; Pl. 2·7

Complete leaf is not preserved, different portions of leaves ranging in size from 3.4-4.4 cm in length and 1.4-1.7 cm in width are preserved; leaves linear in shape, apex acute, midrib thin, 0.5 mm wide, gradually tapers upwards, persistent; secondary veins arise at acute angles, curve backwards to meet margin and after anastomosing and dichotomising, form long, narrow meshes.

Comparison—The venation pattern of the leaves compares well with *G. tenuifolia* (Pant & Gupta, 1968; Tewari, 1996).

Number of specimens—Three.

GLOSSOPTERIS SPATULATA Pant & Singh, 1971

Pl. 2·2

Leaf incomplete, apical half of leaf is preserved; specimen measures 8·2 cm in length and 3·2 cm in width; apex rounded, obtuse, midrib 1 mm wide, thinning towards apex,

persistent, distinct; secondary veins arise at acute angles, curve slightly backwards to meet margin and after anastomosing and dichotomising, form narrow, elongate meshes which are smaller and narrower towards margin, venation dense.

Comparison—The venation pattern of the leaf is comparable with *G. spatulata* (Pant & Singh, 1971; Tewari, 1996).

Number of specimen—One.

Scale leaf

Pl. 2·8

Leaf measures 2 x 1·3 cm in size, shape ovate, apex acute, base cuneate, margin entire; venation reticulate, veins apparently arise from base of leaf and then spread out towards margins; meshes short, narrow, elongate.

Equisetalean stems

Specimens measure 2·3-6·7 cm in length and 0·8-2·3 cm in width; nodes and internodes present in one of the specimens, internodes measure 1·5-1·9 cm in length, ridges and furrows present, do not alternate with those of adjacent internode, striations present in between two ridges which are 1 to 1.5 mm apart.

Number of specimens—Three.

DISCUSSION AND CONCLUSION

The plant fossils from the Talchir Formation represent an early developmental phase of Glossopteris flora in India. There is no record of megafossils from basal Talchir Boulder Beds. However, palynofossils are recorded from Jayanti Coalfield (Lele & Karim, 1969). Megafossils are known from the successive needle shales and sandstones distributed in South Rewa Gondwana Basin, Giridih, Auranga, Hutar and North Karanpura coalfields. Three floral zones have been recognised in the flora of Talchir Formation (Chandra *et al.*, 1992). The lower two zones are exclusively dominated by the leaves of *Gangamopteris*, whereas, the upper zone is characterised by the distinct presence of *Glossopteris* leaves, as has been observed in Rikba beds of North Karanpura Coalfield (Lele, 1966).

Present record of seven species of *Gangamopteris* and six species of *Glossopteris* in Talchir beds of Auranga Coalfield suggests affinity with the flora of upper part of Talchir Formation. The increased proportion of *Glossopteris* leaves in Auranga Coalfield from two to six species contradicts the earlier hypothesis that, the *Gangamopteris* leaves are the earliest representative of Glossopteris flora (Lele 1966; Chandra *et al.*, 1992). Rather, it exemplifies that *Gangamopteris* and *Glossopteris* leaves survived simultaneously since the beginning phase of Glossopteris flora. Presence of *Glossopteris* species e.g., *G. stenoneura*, *G. tenuifolia* and *G. spatulata*, earlier known only from upper horizons of Lower Gondwana i.e., Barakar and Raniganj formations suggests the ancestry of advanced species of *Glossopteris* leaves (Srivastava, 1992).

Acknowledgements—*We are thankful to Prof Anshu K. Sinha, Director, BSIP, Lucknow for his kind permission to publish the paper. (BSIP/RCPC/1999-112).*

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