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Morpho-cuticular study of *Glossopteris stenoneura* Feistmantel from the Barakar Formation of Raniganj Coalfield, West Bengal

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ABSTRACT

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The morphological and cuticular features of well preserved leaves of *Glossopteris stenoneura* Feistmantel collected from Barakar Formation of Churulia area, Raniganj Coalfield are analyzed. The study indicates that spathulate shaped leaves are distinct in having narrow-elongate trapezoidal meshes near the midrib and short, narrow meshes near the margin of leaves. Cuticle is amphistomatic, the surface of upper cuticle characteristically shows fine striations over the vein area. Stomata are anomocytic, oval-elongate with cutinized guard cells. Subsidiary cells of lower cuticle demonstrate papillae overhanging stomata.

Key-words—Morphology, Cuticle, *Glossopteris stenoneura*, Barakar Formation, Raniganj Coalfield.

पश्चिम बंगाल के रानीगंज कोयला क्षेत्र के बराकार शैलसमूह से *ग्लॉसॉप्टेरिस स्टेनोन्यूएरा* फाइस्टमंटेल की उपचर्मीय संरचना का अध्ययन

ए.के. श्रीवास्तव, रजनी तिवारी एवं दीपा अग्निहोत्री

सारांश

रानीगंज कोयला क्षेत्र के चुरूलिया क्षेत्र के बराकार शैलसमूह से एकत्रित *ग्लॉसॉप्टेरिस स्टेनोन्यूएरा* फाइस्टमंटेल की सुपरिरक्षित पर्णों के आकारिकीय तथा उपचर्मीय लक्षणों को विश्लेषित किया गया है। यह अध्ययन इंगित करता है कि स्पेचुलाकार आकार पर्णे मध्य शिराओं के निकट संकीर्ण लम्बी समलम्ब जालियों तथा पर्णों के सीमांत के निकट छोटी, संकीर्ण जालियों के होने पर भी सुस्पष्ट हैं। उपचर्म उभयरंध्री है, ऊपरी उपचर्म का तल विशेष प्रकार से शिराओं के क्षेत्र के ऊपर पतली धारियां प्रदर्शित होती है। स्टोमेटा एनोमोसाइटिक, क्यूटिनमय रक्षक कोशिकाओं सहित अण्डाकार-लम्बे हैं। निम्न उपचर्म की सहायक कोशिकाएं बाहर लटके स्टोमेटो पैपिले प्रदर्शित करती हैं।

संकेत-शब्द—आकार विज्ञान, उपचर्म, *ग्लॉसॉप्टेरिस स्टेनोन्यूएरा*, बराकार शैलसमूह, रानीगंज कोयला क्षेत्र।

INTRODUCTION

GLOSSOPTERIS stenoneura Feistmantel 1877 has been reported by various workers from different Gondwana basins of India, *viz.* Damodar-Koel, Wardha-Godavari, Son-Mahanadi and Satpura (Lakhanpal *et al.*, 1976; Chandra & Singh, 1992; Chandra & Surange, 1979; Chandra & Tewari, 1991; Singh *et al.*, 2006; Srivastava & Agnihotri, 2010; Srivastava & Tewari, 1996, 2001; Tewari, 2007, 2008; Tewari & Jha, 2006; Tewari & Rajanikanth, 2001; Tewari & Srivastava, 1996, 2000a, b). However, the study of leaf morphology in relation with the cuticular features has not been examined so far.

Well preserved coalified compressions of the leaf specimens of *G. stenoneura* were collected from a section exposed in a quarry about 250 m east of Churulia Railway Station (23°47'15" N 87°5'16") situated in north-eastern part of the Raniganj Coalfield, West Bengal (Fig. 1). Geology of the area has been provided by Mehta (1956), Bandyopadhyay (1958) and Biswas (1966) and they have reported following plant fossils: *Gangamopteris angustifolia, G. cyclopteroides, Gangamopteris* sp., *Glossopteris ampla, G. communis, G. indica, G. stricta, Glossopteris* sp. *Sphenopteris polymorpha, Vertebraria indica, Noeggerathiopsis hislopii, Taeniopteris danaeoides, Taeniopteris* sp.,

Fig. 1—Geological map of Churulia area showing fossil locality (after Biswas 1966).

Sphenophyllum sp., *Buriadia sewardii, Rhipidopsis ginkgoides, Rhipidopsis* sp. and *Gondwanidium* sp. Chandra and Srivastava (1981) discovered 10 leaves of *G. ornatus* in two close verticils, apparently showing whorled arrangement from the Churulia area. Maheshwari and Tewari (1992) and (Tewari, 2000) have carried out in detail the morphological and cuticular analyses of *Glossopteris* and described new species mainly on the basis of cuticular characters, *viz. G. pseudocommunis, G. asansolensis, G. bunburyana, G. manjuiae, G. schimperi, G. ednae, G. kusumiae, G. roylei* and *G. ashwinii* and also recorded *G. karanpurensis, G. pandurata, G. damudica* and *G. danae* on the basis of external morphological features. In the present communication cuticular characters of *Glossopteris stenoneura* Feistmantel 1877 have been analyzed in consonance with the morphological characters of the leaf.

Glossopteris stenoneura Feistmantel, 1877

(Pl.1.1-11)

Description—Leaves complete, spathulate in shape, apex obtuse, base narrow, margin entire measuring 6-6.1 cm in length and 2.2-2.4 cm in width at the widest part, which is near the apical region, midrib distinct, striated, persistent, 2 mm wide in basal region and 1 mm wide in the apical region; evanescent near the apex. Secondary veins arise at an angle of 40°-45°, slightly arch backwards to meet the margin, after dichotomization and anastomoses, form narrow, elongate, trapezoidal meshes near midrib and short, narrow meshes near the margin. Meshes are 4.5-5 mm long and 0.6-0.8 mm broad near midrib, 2-3.5 mm long and 0.4-0.5 mm broad near the margin, density of veins is 12-20 veins/cm.

Cuticle amphistomatic, upper cuticle of lamina differentiated into vein and mesh areas, cells of veins narrow, elongate, rectangular, arranged end to end in 4-6 rows, measure 341-689 μm in length and 100-146 μm in width, cells of mesh areas polygonal to irregular, arranged irregularly, 325-355 μm long and 172-281 μm wide, lateral walls of cells of veins 10-31 μm wide and those of cells of meshes 23-27 μm wide, straight to arched, surface walls scabrate, cells of veins striate, subsidiary cells 5-6 in number, like other epidermal cells, 145-375 x 125-299 μm in size with 21-22 μm wide lateral walls, stomata haplocheilic, monocyclic, anomocytic, oval, measure 301-419 x 248-276 μm in size, guard cells superficial, measure 301-419 x 74-117 μm in size with 10-17 μm wide walls, stomatal pore 135-241 μm long and 44-92 μm wide, stomatal index varies from 2.4-5.8; lower cuticle of lamina differentiated into vein and mesh areas, cells of veins narrow, elongate, rectanguloid, arranged end to end in rows, measure 89-233 μm in length and 15-85 μm in width, cells of mesh areas obscure, polygonal to irregular where visible, arranged irregularly, 135 x 88 μm in size, lateral walls of cells of veins 10-31 μm wide, those of cells of meshes not distinct, wherever visible 8 μm wide, straight to arched, surface walls scabrate, subsidiary cells 5-6 in number, like other epidermal cells, sometimes with dome shaped papillae overhanging guard cells, papillae measure 13-18 μm in length, 12-23 μm in width at base and 5-9 μm in width at apex, wall of papillae 2 μm wide, stomata haplocheilic, monocyclic, anomocytic, oval to elongate, measure 56-70 x 23-56 μm in size, guard cells superficial, slightly cutinized, measure 56-70 x 7-16 μm in size with 10-17 μm wide walls, stomatal pore 36-39 μm long and 8-9 μm wide, stomatal index varies from 3.7-8.

Comparison & discussion—Leaves are comparable in shape and venation pattern with *G. stenoneura* Feistmantel (Chandra & Surange 1979; Pl. 1, figs 7, 8; Pl. 15, fig. 8; Pl. 17, figs 1, 4; Srivastava & Tewari 2001, Pl. 2, fig. 2; Tewari & Srivastava 2000a, Pl. 1, fig. 3; Tewari & Srivastava 2000b, Pl. 1, fig. 2; Tewari 2007, Pl. 1, fig. 5; Pl. 7, fig. 2; Tewari 2008, Pl. 2, fig. 2, Pl. 4, fig. 6; Srivastava & Agnihotri 2010, Pl. 3, fig. 5).

Cuticle of *G. stenoneura* is comparable with *G. pseudocommunis* (Pant & Gupta, 1968; Maheshwari & Tewari, 1992, Pl. 2, Figs 5, 8) in being amphistomatic but differs in presence of striations on cells of upper surface and in having papillate subsidiary cells with papillae overhanging stomata on lower surface. Lower cuticle of *G. ednae* compares with that of *G. stenoneura* in having indistinct cell outlines and papillate subsidiary cells overhanging stomata. However, it differs

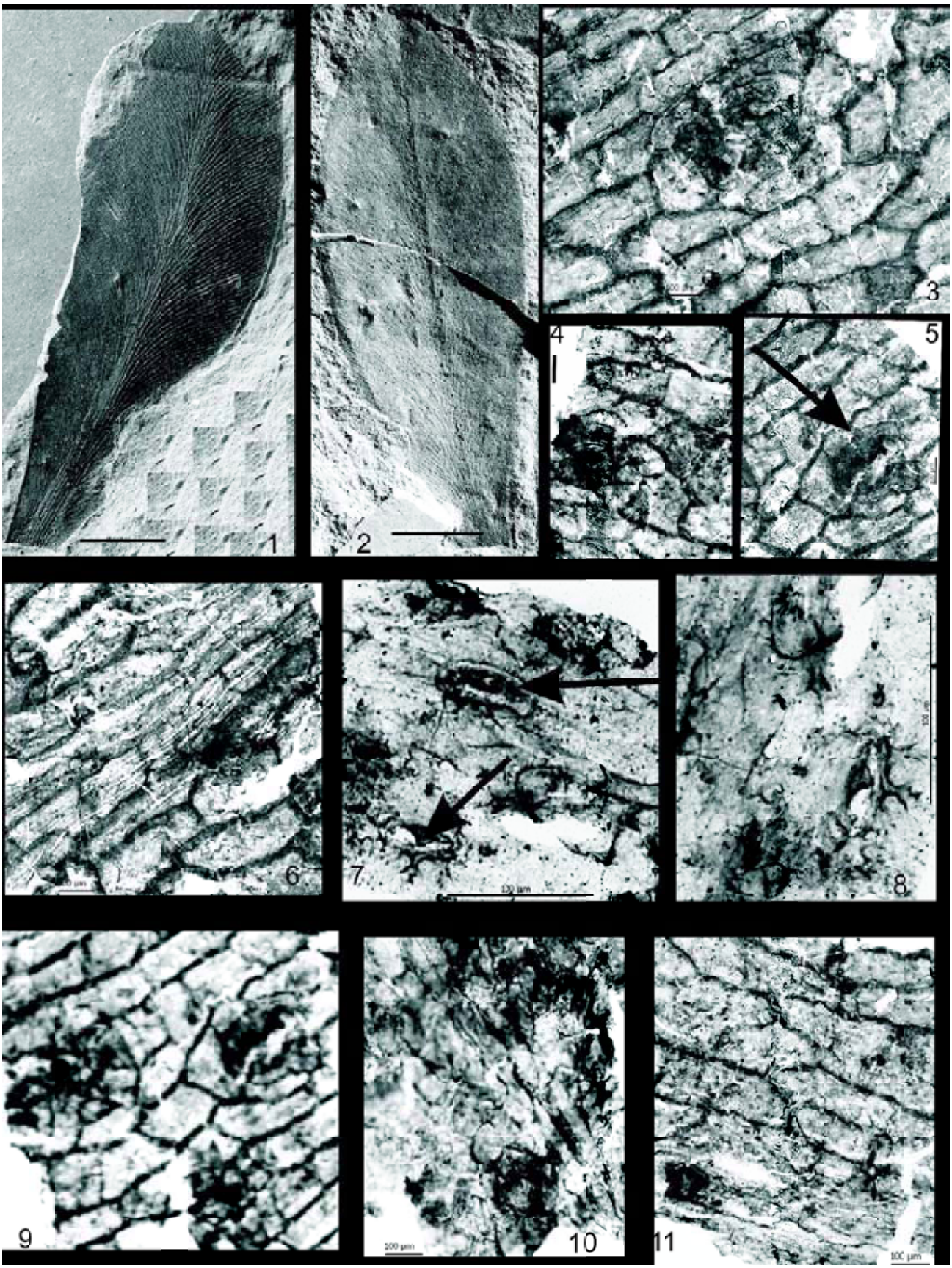

PLATE 1

by being hypostomatic, in presence of papillate surface walls and in external morphology (Maheshwari & Tewari, 1992, Pl. 6, Figs 5, 8; Pl. 7, Fig. 1). Lower cuticle of lamina of *G. kusumiae* compares with lower cuticle of *G. stenoneura* in presence of papillate subsidiary cells but differs in other epidermal characters and overall external morphology (Maheshwari & Tewari, 1992, Pl. 7, Figs 2-5, 8). Upper cuticle of lamina and midrib of *Glossopteris contracta* (Pant & Gupta, 1971, Text-Fig. 8B, D) shows striations. Midrib cuticle, however, is not recorded in *G. stenoneura.* Moreover, lower cuticle of lamina of *Glossopteris contracta* differs in having sinuous lateral walls (Text-Fig. 7D) and papillate surface walls of (Text-Fig. 8A).

Feistmantel (1877) proposed the species *G. stenoneura*, and in 1881 (Pl. 32, Fig. 3; Pl. 33, Fig. 2) described the species as variety of *G. communis*, i.e. *G. communis var. stenoneura*. The variety was raised to the specific rank by Banerji *et al.* (1976) without examining the original assignment of the species by Feistmantel (1877). Chandra and Surange (1979) studied the morphological features of the species and included the leaves described by Kar (1968) as *G. decipiens* and *G. fusa* by Kulkarni (1971) under *G. stenoneura*. Pant and Gupta (1968) have described poorly preserved cuticular pieces from the fragments of *G. communis var. stenoneura* vide Specimen No. 5269, 1881, Geological Survey of India, Kolkata. The correlation of morphological characters with the cuticular features have not been attempted by Pant and Gupta (1968).

Present study for the first time records the detail description of morphology and cuticular structures of *G. stenoneura* Feistmantel 1877.

No. of specimens—Four.

PALAEOECOLOGICAL IMPLICATIONS

The cuticular characters are extremely significant in interpretation of climate (Stace, 1965; Cutler, 1982; Kovach & Dilcher, 1984; Upchurch, 1995). Climatically sensitive features observed in the cuticle of *Glossopteris stenoneura* are the size of cells which varies from small to large, nature of anticlinal /lateral walls which are straight to arched, surface features like presence of striations and papillae, frequency of stomata which is low to moderate and amphistomatic nature of cuticle. Usually, features like small cell size, straight lateral walls, striate, rough/scabrate surface walls, thickened cutinized guard cells, papillate subsidiary cells overhanging stomata and amphistomatic nature are associated with xerophytic conditions. However, other characters like large cell size and low stomatal frequency are features characteristic of plants growing in mesophytic conditions, i.e. damp, shaded and humid conditions. Striations are adapted by plants as prevention against overheating and are effective in scattering and reflection of heat. These, thus indicate high light intensity. Amphistomatic nature indicates less precipitation. However, majority of *Glossopteris* species reported from Churulia area (Maheshwari & Tewari, 1992) are hypostomatic and indicate heavy precipitation. Therefore, on the basis of the present cuticular studies and an analysis of previous work, climate during deposition of Barakar sediments in the Churulia area can be deduced as warm, humid with spells of high and low light intensities.

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←

PLATE 1

(Scale Bar 1-2 x 1 cm, 3-11 x 100 μm)

1. *Glossopteris stenoneura.* BSIP Specimen No. 39850.
2. *Glossopteris stenoneura*. BSIP Specimen No. 39851.
3-5. Upper surface of lamina. BSIP Slide No. 140140.
5. Upper surface of lamina showing stoma (indicated by arrow). BSIP Slide No. 140140.
6. Upper surface of lamina showing striations. BSIP Slide No. 140138.
7, 8. Lower surface of lamina showing stomata and papillae overhanging guard cells (indicated by arrow). BSIP Slide No. 140141.
9. Lower surface of lamina showing stomata. BSIP Slide No. 140138.
10. Lower surface of lamina showing vein and mesh areas. BSIP Slide No. 140141.
11. Upper surface of lamina. BSIP Slide No. 140139.

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