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Fossil flora of the Chui Hill, Jabalpur Formation, Satpura Basin, Madhya Pradesh, India

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ABSTRACT

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Diversed types of fossil leaf impressions have been collected in abundance on reddish-pinkish clay from the Chui Hill, Jabalpur Formation of Satpura Basin. The flora has dominance of conifers followed by bennettitales and pteridophytes, e.g., *Elatocladus jabalpurensis, Elatocladus* sp., *Brachyphyllum jabalpurensis* sp. nov., *Pagiophyllum chawadensis, Araucarites minutes, Satpuria sehoraensis, Taeniopteris spatulata, Ptilophyllum cutchense* and *Anomozamites* sp. These taxa are commonly found in Early Cretaceous floral assemblages of India. The floral assemblage is compared with other contemporaneous deposits of Satpura and South Rewa basins.

Key-words—Clay impressions, Megaflora, Dominance conifers, Early Cretaceous.

भारत के मध्य प्रदेश प्रान्त की सतपुड़ा द्रोणी के जबलपुर शैल समूह की चुई पर्वत श्रेणी का अश्मित वनस्पतिजात

नीरू प्रकाश

सारांश

सतपुड़ा द्रोणी के जबलपुर शैल समूह की चुई पर्वत श्रेणी से प्राप्त लाल गुलाबी मृतिका की प्रचुरता में अश्मित पर्ण मुद्राश्यों के विभिन्न प्ररूप संग्रहीत किए गए है । वनस्पतिजात में शंक्वाकारों की प्रचुरता है, तत्पश्चात् क्रमशः बेनीटाइटेलीज तथा टेरिडोफाइट, जैसे—*इलेटोक्लेडस जबलपुरेन्सिस, इलेटोक्लेडस* प्रजाति, *ब्रैकीफिल्लम जबलपुरेन्सिस* नव प्रजाति, *पेजियोफिल्लम चावाडेन्सिस, अराउकेराइटीज माइन्यूटीज, सतपुड़िया सिहोरेन्सिस, टीनियॉप्टेरिस स्पाच्यूलाटा, स्पाच्यूलाटा, टिलोफिल्लम कचेन्स* तथा *एनोमोजेमाइटीज* प्रजाति आते हैं। ये वर्गक भारत के प्रारंभिक क्रिटेशस वनस्पतिजात समुच्चय सतपुड़ा तथा दक्षिणी रीवॉ द्रोणियों के अन्य समकालिक निक्षेपों से तुलनीय है।

संकेत शब्द—मृत्तिका मुद्राश्म, गुरूवनस्पतिजात, प्रभावी शंक्वाकार, प्रारंभिक क्रिटेशस।

INTRODUCTION

THE Upper Gondwana strata of Jabalpur Formation is exposed around Mahadeo Hills and is recognised by its carbonaceous or coaly content or reddish brown and whitish-grey clays. Earlier it was referred as 'Damuda Series' by Oldham (1893) but later he placed these sequences under Jabalpur Group. Several sedimentary outliers occur near Narsinghpur (Sehora), Jabalpur in Satpura Basin and in Bansa and Chandia of South Rewa Gondwana Basin. Feistmantel (1877) recorded

fragmentary plant megafossils from various localities of Jabalpur Formation. Few sporadic reports were made by Deb (1917) and a note is published by Agarwal (1963). In this paper morphotaxonomic study of plant megafossils has been carried for the first time to augment the flora of Chui Hill. Their interrelationship with South Rewa and Rajmahal basins also attempted and observed that these floras were dominant in the same period.

GEOLOGY AND AGE

The sedimentary rocks of Jabalpur Formation, Satpura Basin unconformably overlies Precambrian basement which are further overlain by Lameta or Deccan Intertrappean beds (Fig. 1). The rocks of Jabalpur Formation consist of massive sandstone, soft white clays, jaspar bearing sandy conglomerate, earthy nodules of haematite, thin strips of carbonaceous and red clays associated with cherts. The Jabalpur sediments attain its maximum thickness about 150 m near the vicinity of Hard and Sukkur River towards east of Chhindwara-Narsinghpur Road. At the vicinity of Sher River these sediments attained maximum thickness of about 75 m and appear to be quite massive.

Crookshank (1936) and Pascoe (1959) biostratigraphically subdivided 'Jabalpur Series' into Lower (Chaugan) and Upper (Jabalpur) Formation. They suggested that the Umia plant bed should be associated with Jabalpur Group on the basis of occurrence of conifers and absence of cycades. Whereas,

Formation	Beds with Lithological characters	Age
	Laterite, old and recent Alluvium soil caps	Recent
Deccan Trap/ Lameta	Lava flows Coarse, calcareous, conglomerate, limestone, purple grits/sills, green sandstone	Late Cretaceous-Palaeocene Late Cretaceous
	UNCONFORMITY	
Jabalpur	Sandstone alternating with clays, conglomerate, earthy haematite, coal, carbonaceous shale, red clay and bed of chert	Jurassic-Early Cretaceous
	UNCONFORMITY	
Denwa	Alternating bed of sandstone and variegated clays (red green and buff coloured clays)	Triassic
Bagra	Conglomerates, limestone and variegated red clays	
	UNCONFORMITY	
Lower Gondwana		Permian
	Archaean basement	Azoic

(Partially modified after Kumar, 1994)

Fig. 1—Showing sedimentary sequences around the area.

PLATE 1

1 *Ptilophyllum cutchense* Morris. Specimen No. BSIP 38010. x 1
2. *Cladophlebis medlicottiana* (Oldham) Pascoe. Specimen No. BSIP 38005. x 2.
3. *Pachypteris indica* (Oldham & Morris). Bose and Roy. Specimen No. BSIP 38006. x 1.
4. *Elatocladus jabalpurensis* (Feistmantel) Sahni, Specimen No. BSIP 38881 x 1.
5 *Araucarites minutes* Bose and Maheshwari. Specimen No. BSIP 38015. x 1
6. *Pagiophyllum chawadensis* Bose and Banerji. Specimen No. BSIP 38013. x 1.
7 *Taeniopteris spatulata* McClelland. Specimen No. BSIP 38007. x 1
8. *Elatocladus jabalpurensis* (Feistmantel) Sahni. Specimen No. BSIP 380011 x 3.
9. *Anomozamites* sp., Specimen No. BSIP 38008. x 1
10. *Elatocladus jabalpurensis* (Feistmantel) Sahni, Specimen No. BSIP 38011 x 1
11 *Elatocladus jabalpurensis* (Feistmantel) Sahni. Specimen No. BSIP 38017 x 1
12. *Satpuria sehoraensis* Sukh-Dev and Zeba-Bano. Specimen No BSIP 38016. x 1
13. *Anomozamites* sp., Specimen No. BSIP 38018. x 1.
14. *Elatocladus* sp., Specimen No. BSIP 38012. x 1
15. *Satpuria sehoraensis* Sukh-Dev and Zeba-Bano. Specimen No. BSIP 38016. x 2.
16. *Araucarites minutes* Bose and Maheshwari. Specimen No. BSIP 38015. x 1
17 *Araucarites minutes* Bose and Maheshwari, Specimen No. BSIP 38880. x 1.
18. *Anomozamites* sp., Specimen No. BSIP 38008. x 2.
19. *Brachyphyllum jabalpurensis* sp. nov., Specimen No. BSIP 38014. x 1 (Holotype).
20. *Elatocladus jabalpurensis* (Feistmantel) Sahni. Specimen No. BSIP 38019. x 1
21 *Ptilophyllum cutchense* Morris. Specimen No. BSIP 38010. x 4.

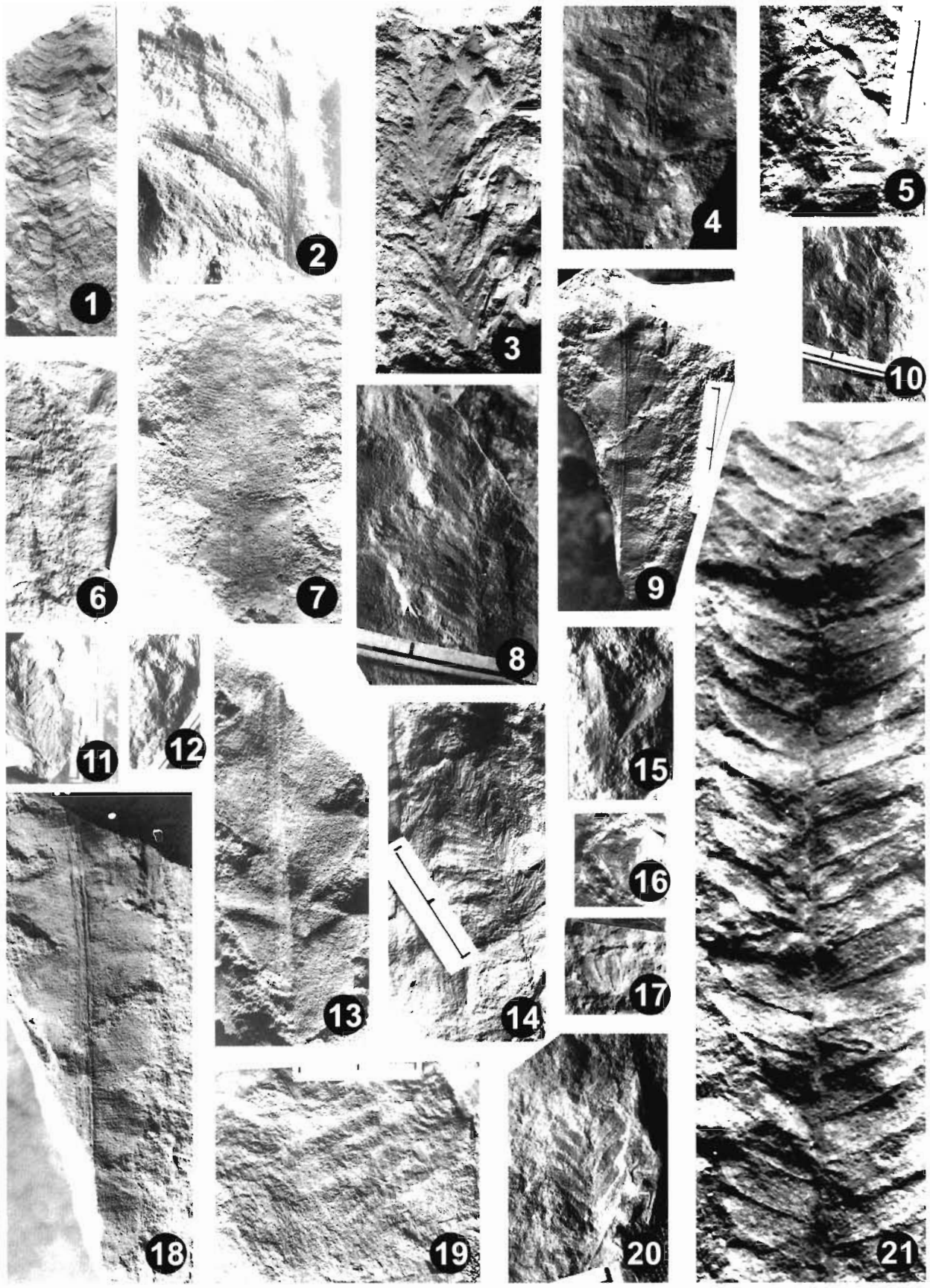

PLATE 1

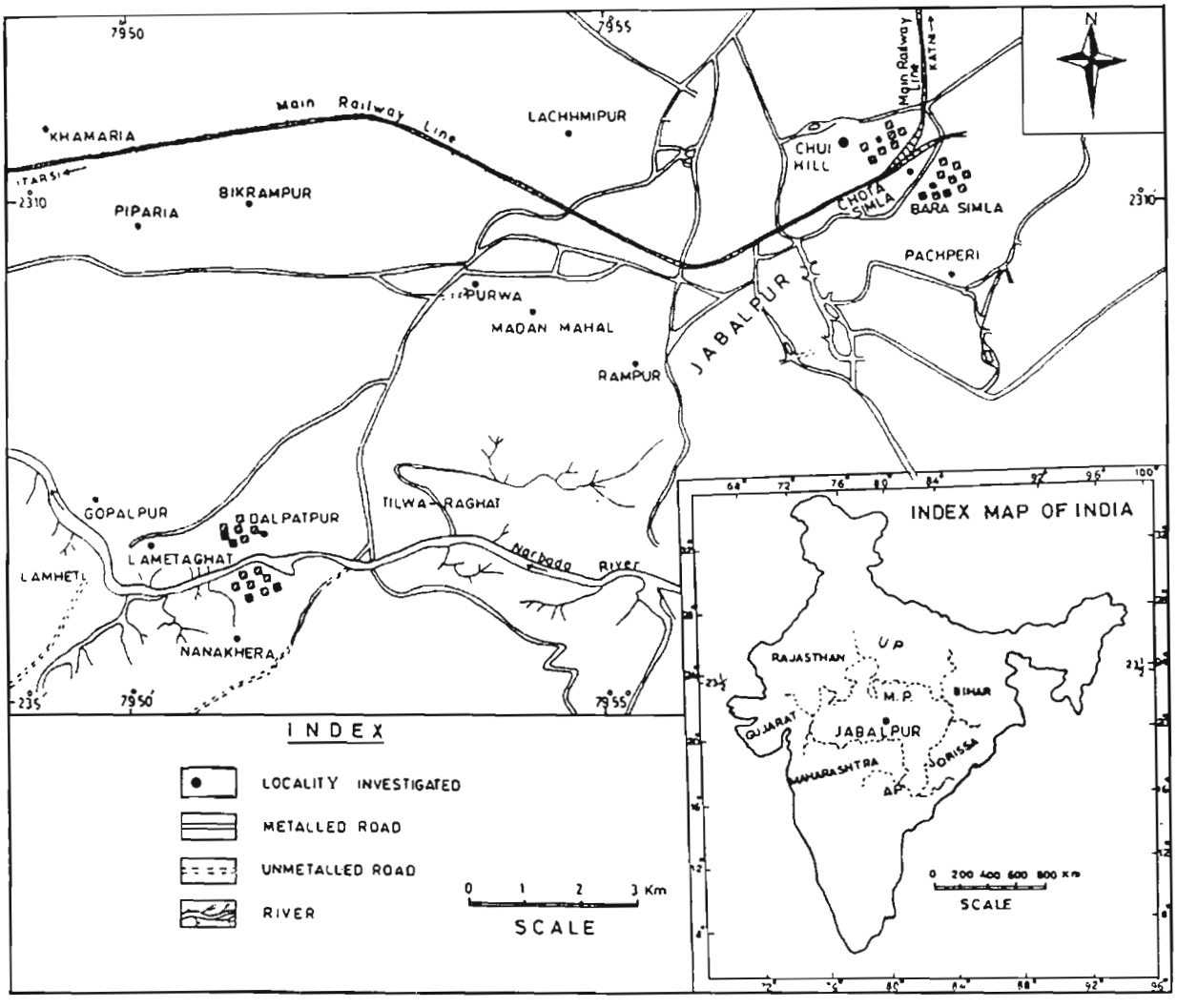

Fig. 2—Locality map of the area (after Dogra *et al.*, 1994)

Singh (1966, 1970) palynologically assigned Lower Cretaceous age to Jabalpur Formation. However, Bharadwaj (1970) and Bharadwaj *et al.* (1972) concluded Upper Jurassic age on the basis of high frequencies of *Cycadopites* and *Classopollis*. But Singh and Venkatachala (1988) while reassessing the palynoflora dated an Early Cretaceous age for Jabalpur Formation.

MATERIAL AND METHODS

Plant megafossils dealt in present study have been collected from exposed sequence at Chui Hill (24°41' : 78°38') near Jabalpur Town (Fig. 2). All these megafossils are preserved as impression on reddish brown or white grey clays. The specimens of the present study are housed in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

UNCLASSIFIED FERN

Genus—CLADOPHLEBIS Brongniart 1849

CLADOPHLEBIS MEDLICOTTIANA (Oldham) Pascoe 1959

Pl. 1-2

Synonym—Alethopteris medlicottiana (Oldham) Feistmantel, 1877, p. 87, pl. 1, figs 2-6.

Description (Emended)—(Based on Feistmantel's and present specimens) Frond bipinnate, pinnae alternate broad at base, narrowing towards distal end, measuring 1·9-3 cm in length and 1·7-2·2 cm in width, making an angle of about 60° to main rachis. Main rachis 3 mm wide. Pinnules linear, straight or slightly falcate, rarely bent backward, broader at base, gradually narrowing towards apex, 2-2·4 cm long and 0·2-0·4 cm wide,

arising at an angle of about 40°-60°, angle of divergence less towards apical region. Pinnules attached to rachis by entire base. Acroscopic basal margin extending upward and sometimes joined togather by a narrow web. Apex acute or obtuse. Midrib prominent, originating closer to basiscopic edge of pinnule, persisting up to apex. Secondary veins numerous, catadromic, arising at an angle of about 20°-30°, forking once.

Comparison—The specimens of *Cladophlebis medlicottiana* (Oldham) Pascoe (1959) described by Sukh-Dev (1970) and Zeba-Bano (1980) from various localities (Bansa, Sehora, Hard River, Jatamao and Patparha) of Jabalpur Formation resembles in shape, size and venation pattern. This specimen shows apparent resemblance with *Cladophlebis* sp. described by Bose and Sah (1968) from Lower Cretaceous of Rajmahal Hills, where secondary veins are forked more than once but in *C. medlicottiana* secondary veins are only once forked.

Collection—Specimen no. BSIP 38005.

GYMNOSPERMS

Family—CORYSTOSPERMACEAE

Genus—PACHYPTERIS Brongniart 1828

PACHYPTERIS INDICA (Bose & Roy) Bose & Banerji 1984

(Pl. 1·3)

Remarks—*Pachypteris indica* is reported for the first time from Chui Hill, Jabalpur Formation. The specimen matches exactly with the *Pachypteris indica* (Bose & Roy) Bose & Banerji (1984) in shape, size and venation pattern. The only difference is that the present specimen lack cuticle. Apparently it also resembles with *P. lanceolata* Harris (1964) from Jurassic of Yorkshire, England. However, latter differs in having broad and lanceolate pinnules.

Collection—Specimen no. BSIP 38006.

CYCADALES

Family—CYCADACEAE

Genus—TAENIOPTERIS Brongniart 1832

TAENIOPTERIS SPATULATA McClelland 1850

(Pl. 1·7)

Remarks—The specimen described here resembles *Taeniopteris spatulata* McClelland (1850) described by Bose & Banerji (1981) from the Rajmahal Hills showed presence of loops in secondary veins, which are not observed in the present specimen.

Collection—Specimen no. BSIP 38007.

BENNETTITALES

Family—WILLIAMSONIACEAE

Genus—PTILOPHYLLUM Morris, 1840

PTILOPHYLLUM CUTCHENSE Morris 1840

(Pl. 1·1, 21)

Remarks—*Ptilophyllum cutchense* occurs frequently in Jabalpur Formation but not so common in Chui Hill.

Collection—Specimen no. BSIP 38010.

Genus—ANOMOZAMITES Schimper 1870

ANOMOZAMITES sp.

(Pl. 1·9, 13, 18)

Description—Leaves 1·7-8·5 cm in length and 1·4-1·8 cm in width, incomplete. Rachis prominent, about 2 mm wide, longitudinally striated. Lamina-segments sub-opposite to opposite, broader than their length, attached to rachis at about right angle by entire base, 6-8 mm long and 7-14 mm broad. Lateral margins entire, distal margin broad with rounded or pointed corners; occasionally distal margin notched. Veins arising at right angle, simple, parallel, sometimes forked.

Comparison—*Anomozamites* sp. is comparable to *A. amarjolense* Sharma *et al.* (1971), *A. fissus* Feistmantel (1879) and *A. hasnapurensis* described by Bose & Banerji (1981). But all these species differ from *Anomozamites* sp. by squarish segments or twice in length than breadth. *A. thomsi* Harris (1960) described from Yorkshire do resembles in shape and size with present specimen but mostly they are longer than broad.

Collection—Specimen nos BSIP 38008, 38009 and 38018.

CONIFERALES

Family—PODOCARPACEAE

Genus—ELATOCLADUS Halle, 1913

ELATOCLADUS JABALPURENSIS (Feistmantel) Sahni, 1928

(Pl. 1·4, 8, 10, 11, 20)

Synonyms—*Palyssa jabalpurensis* Feistmantel (1877), p. 96, pl. 9, figs 1-6, pl. 10, fig. 1.

Lectotype—*Elatocladus jabalpurensis* (Feistmantel), Sahni (1928), p. 14, pl. 5, fig. 73. pl. 10, fig. 1 (Feistmantel, 1877).

Diagnosis (Emended)—Branched leafy twigs, 2·1-9·0 cm long and 0·8-7·5 cm wide. Branches stiff and spreading, arising at an angle of 30°-70°. Leaves spirally borne but lying in one plane, narrow linear-lanceolate, straight, measuring 3-10 mm in length and about 1 mm in width, attached at an angle of 20°-

Name	Sehora	Jabalpur	Bansa
Pteridophytes			
Todites indicus	+	-	-
Cladophlebis indica	-	-	+
C. medlicottiana	+	+	+
Cladophlebis sp. cf. *C.longipennis*	+	-	-
Cladophlebis sp.	+	-	-
Gleichenia rewahensis	-	-	+
G. nordenskioldii	-	-	+
Hausmannia pachyderma	-	-	+
Phlebopteris polypodiodes	-	-	+
Onychiopsis psilotoides	-	-	+
O. paradoxus	-	-	+
Weicheselia reticulata	-	-	+
Sphenopteris sp. cf. *sarguta*	+	+	-
Sphenopteris cf. *C. otagoensis*	-	+	-
Sphenopteris sp.	+	-	-
Pteridospermales			
Pachypteris indica	+	+	-
Cycadopteris pulcherrima	-	-	+
C. brauniana	-	-	+
C. auriculata	-	-	+
C. indica	-	-	+
C. majus	-	-	+
Cycadales			
Pterophyllum princeps	-	+	-
Taeniopteris spatulata	-	+	-
Doratophyllum senii	+	-	-
Anomozamites sp.	-	+	-
Bennettitales			
Ptilophyllum acutifolium	+	-	-
P. cutchense	+	+	-
P. distans	+	-	+
P. horridum	+	-	+
P. jabalpurense	+	-	-
P. gladiatum	-	-	+
Ptilophyllum sp.cf. *P. horridum*	-	-	+
P. rewahensis	-	-	+
Ptilophyllum sp.	-	-	+
Williamsonia seniana	+	-	-
Cycadolepis	+	-	-
Ginkgoales			
Ginkgoites lobata	+	-	-
Pentoxylae			
?Nipaniophyllum hirsuatum	-	-	+
Coniferales			
Elatocladus confertus	-	+	+
E. tennerrima	-	-	+
E. pseudotenerrima	+	-	-
E. plana	+	-	-
E. jabalpurensis	-	+	-
E. sehoraensis	+	-	-
E. bosei	+	-	-
Elatocladus sp.	-	+	-
Araucaria indica	+	-	+
Araucarites cutchensis	+	+	-
A. macropterus	-	-	+

Name	Sehora	Jabalpur	Bansa
A. minimus	+	+	-
A. sehoraensis	+	-	-
A. fibrosa	-	-	+
Araucaria pantiana	-	-	+
Pagiophyllum sherensis	+	-	-
P. satpuraensis	+	-	-
P. marwarensis	-	-	+
P. bansaensis	-	-	+
P. rewahensis	-	-	+
Pagiophyllum sp.	-	+	-
Pagiophyllum sp. cf. *P. peregrinum*	-	-	+
Brachyphyllum jabalpurensis sp. nov.	-	+	-
B. ekaiostomum	+	-	+
B. feistmantellii	-	-	+
B. bansaensis	-	-	+
B. rhombicum	-	+	+
B. sehoraensis	+	-	-
Allocladus bansaensis	+	-	+
A. sehoraensis	+	-	-
Strobilites anceps	-	-	+
Satpuria sehoraensis	+	+	-
Satpuria sp.	+	-	-
Coniferocaulon rajmahalense	+	-	-
Strobilites sewardi	+	+	-
Czekanowskia sp.	-	+	-

Fig. 3—Comparative chart of the Jabalpur flora.

60°, and never swept back. Base constricted and decurrent, margin entire, apex acute or bluntly acute and unicostate.

Remarks—The morphological observations of *Elatocladus jabalpurensis* is based on impressions which is characterised by stiff branches and the leaves are linear, straight and narrow, never swept back and attached to rachis by constricted and decurrent leaf bases. Bose & Banerji (1984) from Kutch, Ganesan & Bose (1982) from Bhutan and Halle (1913) reported similar specimens from Grahamland.

Collection—Specimen nos. BSIP 38011, 38017, 38019 and 38881.

ELATOCLADUS sp.

(Pl. 1·14)

Description—Leafy twig 4·1 cm in length and 0·9 cm in width. Rachis thick, stout about 1 mm wide. Leaves spirally arranged but in one plane; narrow linear, up to 8 mm long and about 1 mm wide, attached to rachis by broad base, margin entire. Midrib distinct up to apex.

Comparison—*Elatocladus* sp. is characterised by long, narrow leaves which are mostly attached by entire bases. *E. plana* (Feistmantel) described by Sahni (1928) are similar in appearance, leaves attached at right angle and are reflexed back. Comparison is also made with *E. longifolia* Borkar and Chiplonkar (1973) from Tarnetar (Saurashtra), leaves of *Elatocladus* sp. are stiff and scale leaves are absent.

Collection—Specimen no. BSIP 38012.

Family—ARAUCARIACEAE

Genus—PAGIOPHYLLUM Heer 1881

PAGIOPHYLLUM CHAWADENSIS Bose & Banerji 1984

(Pl. 1·6)

Description—Leafy-twig 4·8 cm in length and about 0·3 cm in width. Leaves closely appressed on stem, forwardly directed, small, triangular, 1-2 mm long and 1-1·5 mm wide; arising from a rhomboidal leaf base-cushions. Margin entire, apex obtuse or acute.

Remarks—The present specimen resembles morphologically with *Pagiophyllum chawadensis* Bose & Banerji (1984) described from Early Cretaceous of Kutch. Cuticle is unknown in the present material.

Collection—Specimen no. BSIP 38013.

Genus—BRACHYPHYLLUM Brongniart 1828

BRACHYPHYLLUM JABALPURENSIS sp. nov.

(Pl. 1·19)

Diagnosis—Twig leafy, branches cylindrical; leaves rhomboidal, broad, closely appressed on the stem, few leaves elongated, triangular and spirally arranged on distant branches. Leaf cushions rhomboidal, leaf margin straight, apex acute.

Description—Branched leafy-twig 4·4 cm long and 4·5 cm wide. Branches cylindrical arising at an angle of 50°-70° (mostly 60°) up to 3·2 cm long and 0·3 cm wide. Leaves rhomboidal, about 2 mm long and 2 mm broad, closely appressed on stem, a few leaves towards distant end of branch are elongated, triangular and spirally arranged; arising from a rhomboidal leaf base cushion, margin straight, apex acute.

Comparison—Brachyphyllum jabalpurensis is characterised by dimorphism of leaves. Mostly they are rhomboidal, closely appressed on the stem as in *B. rhombhicum* Feistmantel, described by Sahni (1928) but few leaves towards distal end of branch are elongate and triangular. Cuticle is not preserved in *B. jabalpurensis*. It is also comparable with *B. feistmantelii* (Halle) Sahni (1928) in dimorphism of leaves but in the later species larger leaves occur on main branches and smaller ones on short branches.

Holotype—Specimen no. BSIP 38014.

Genus—ARAUCARITES Presl 1838

ARAUCARITES MINUTES Bose & Maheshwari 1973

(Pl. 1·5, 6, 17)

Description—Detached seed scales, 0·8-1·6 cm long and 0·5-0·8 cm wide; cuneate, shoulder convex or straight, in some slightly raised with sloping sides to a narrow base. Tip short, 1-2 mm long, acute. Seed obovate, 4-6 mm long and 2-4 mm wide.

Remarks—Araucarites minutes described here resembles *A. minutes* Bose & Maheshwari (1973), Bose and Banerji (1984) recorded from Early Cretaceous of Sehora and Kutch.

Collection—Specimen nos BSIP 38015 and 38880.

Genus—SATPURIA Sukh-Dev & Zeba-Bano 1978

SATPURIA SEHORAENSIS Sukh-Dev & Zeba-Bano 1978

(Pl. 1·12-15)

Description—Leaves strap shaped, lanceolate, 0·7-1·8 cm long, 0·1-0·2 cm wide, abruptly narrowing towards base and apex; apex acute, bases with a short curved stalk, margin entire. Veins few, faint, parallel and dichotomising.

Remarks—The specimens described here are preserved as impressions. The *Satpuria sehoraensis* (Sukh-Dev & Zeba-Bano, 1978) resembles in gross morphology with the specimens reported from Early Cretaceous of Sehora, but cuticle is unknown in the present specimens.

Collection—Specimen no. BSIP 38016.

FLORAL COMPOSITION AND ITS COMPARISON

The fossil flora of Jabalpur Formation (Satpura Basin) is characterised by dominance of conifers followed by bennettitalian remains. The pteridophytic remains are meagre whereas, Ginkgophytes are rare in occurrence. Pentoxylae have so far not been recorded from Jabalpur Formation.

It is evident from the comparative chart (Fig. 3) the Jabalpur flora (Chui Hill) is closely comparable to Sehora (in both the assemblage conifers are dominant over cycadophytes) but differ due to the occurrence of *Onychiopsis* along with some other cycadophytes e.g., *Anomozamites, Ptilophyllum* and *Taeniopteris*. Although Sukh-Dev (1988) in spite of some difference had placed them together with in the assemblage zone 9.

Bansa flora is characterised by the occurrence of index fossil *Weicheselia* and genus *Cycadopteris* along with pteridophytes viz., *Gleichenia, Hausmannia, Onychiopsis* and *Phlebopteris* with few species of *Ptilophyllum* and cycads are totally absent; is placed in assemblage zone 10 (Sukh-Dev,1988) (the basic difference is that in Jabalpur cycadophytes occur in good number).

The Rajmahal flora is recognised by the dominance of broad leaved cycadophytes and conifers while in Jabalpur flora conifers are the main constituent as compare to the broad leaved cycadophytes.

On the basis of above discussed floral elements Jabalpur flora is younger than Rajmahal and older than Bansa flora, therefore assigned to an Early Cretaceous age.

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