

# Lower Cretaceous plant fossils from Bairam-Belkher area, District Amravati, Maharashtra and District Betul, Madhya Pradesh and their significance in stratigraphy

A.K. SRIVASTAVA<sup>1</sup>, P.D. BANUBAKODE<sup>1</sup>, V.M. KALE<sup>1</sup>, G.V. PATIL<sup>2</sup> AND  
S.R. MANIK<sup>3</sup>

<sup>1</sup> P. G. Department of Geology, Amravati University, Amravati, Maharashtra, India.

<sup>2</sup> Director, Institute of Science, Aurangabad, Maharashtra, India.

<sup>3</sup> P. G. Department of Botany, Amravati University, Amravati, Maharashtra, India.

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## ABSTRACT

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A plant fossil assemblage comprising of *Maonidium indicum*, *Sphenopteris* sp., *Cladophlebis indica*, *Ptilophyllum cutchense*, *P. acutifolium*, *Taeniopteris spaulata*, *T. vitata*, *Pagiophyllum* sp., *Brachyphyllum* sp., *Araucarites cutchense*, *Elatocladus tenerrimus*, *E. sp.*, *E. kingianus* and *Elatocladus* sp. A has been described from a new locality of Bairam-Belkher area in District Amravati, Maharashtra and District Betul, Madhya Pradesh. *Ptilophyllum* and *Maonidium* are the most abundant genera in this assemblage. An attempt has also been made to compare the present assemblage which show an affinity with the Lower Cretaceous assemblages of Peninsular India, i. e., Himmatnagar, Gardeshwar, Gollapalle, etc. On the basis of various taxa belonging to Bennettitales and Filicales, a warm and humid climate has been interpreted.

**Key-words**—Plant megafossils, Early Cretaceous, Upper Gondwana (India), Bennettitales, Filicales, Cycadales.

## सारांश

महाराष्ट्र के अमरावती जनपद तथा मध्य प्रदेश के बैतूल जनपद के बैरम-बेलखर क्षेत्र से प्राप्त अधोक्रिटेशसयुगीन पादपाशम तथा उनकी स्तरकीय सार्थकता

अशोक कुमार श्रीवास्तव, प्रदीप देवीदास पंत बानुबकोडे, विवेक मोतीरामजी काले, गणेश व्यंकटराव पाटील एवं सुरेन्द्र राघोबा माणिक

महाराष्ट्र के अमरावती जनपद तथा मध्यप्रदेश के बैतूल जनपद में स्थित बैरम-बेलखर क्षेत्र की एक नई संरिथति से एक पादपाशम समुच्चय अंकित किया गया, जिसके अन्तर्गत मैटोनीडियम इन्डिकम, स्फेनोप्टेरिस प्रजाति, क्लैडोफ्लेबिस इन्डिका, टिलोफिल्लम कचेन्स, पी. एक्यूटीफोलियम, टीनिऑप्टेरिस स्पैच्युलेटा, टी. विट्टाटा, पैजियोफिल्लम प्रजाति, ब्रैकीफिल्लम प्रजाति, आरॉकैराइटीज कचेन्स, इलैटोक्लैडस टीनेरिमस, इलैटोक्लैडस प्रजाति, ई. किन्जिएनस तथा इलैटोक्लैडस प्रजाति ए सम्मिलित हैं। टिलोफिल्लम तथा मैटोनीडियम इस समुच्चय के सर्वाधिक बाहुल्य वाले वंश हैं। इस समुच्चय की वर्तमान समुच्चय से तुलना करने पर भारत के प्रायद्वीपीय क्षेत्रों (जैसे-हिम्मतनगर, गरदेश्वर, गोलापल्ली इत्यादि) के अधोक्रिटेशसयुगीन समुच्चयों के साथ सजातीयता प्रदर्शित हुई है। वेनेटिलीज तथा फिलिकेलीज से सम्बन्धित विभिन्न वर्गकों के आधार पर एक उष्ण तथा आर्द्र जलवायु का निर्वचन किया गया है।

## INTRODUCTION

THE sedimentary sequence exposed in the Bairam-Belkher area is represented by the Gondwana and Lametas. The sediments are about 100 m in thickness consisting of sandstone, shale and clay beds having a dip of 10°-15° north (Text-figures 1, 2). The sequence, though reported a century back, could not get much attention. The earlier workers have made very casual comments where as in the past 2-3 decades, the sequence has been locally studied because of the clay deposits having economic value (Arogyaswami, 1968). Blanford (1869) first reported the sequence and correlated it with the Mahadeva. Pascoe (1959) considered it as an inlier and correlated it with Kamathi and (?) Mahadeva. Adyalkar (1975) and Bhusari (1979) ranked it Upper Triassic and equated with Pachmari and Maleri. All the correlations made by these workers are based on the lithological characters and no palaeontological evidences are taken into consideration. Kumar (1990), for the first time, recorded spores and pollen from Belkher area and considered it of Neocomian-Aptian age. Recently, Srivastava *et al.* (1995) collected a huge assemblage of leaf impressions and considered them to be of Lower Cretaceous age.

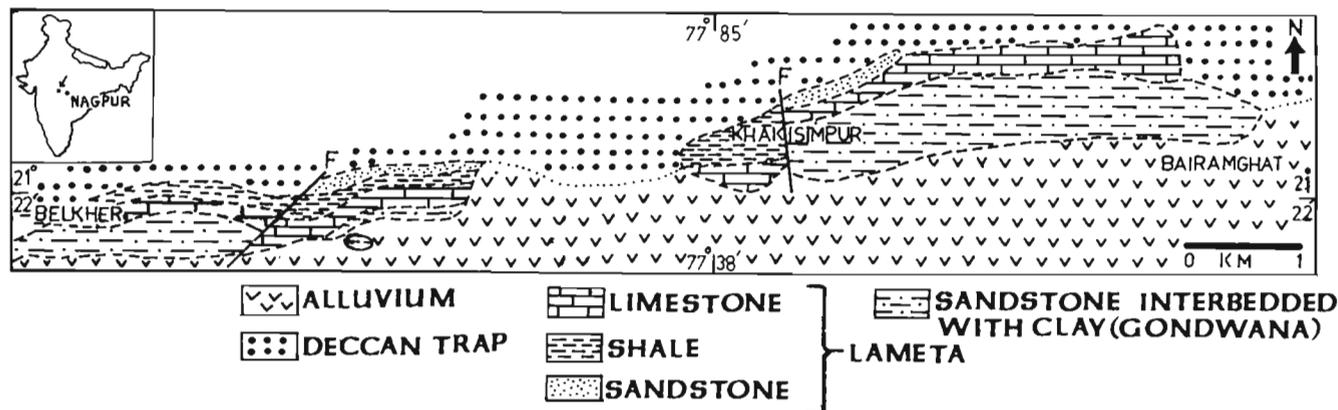
The plant fossils have been recorded from the clay horizons occurring as lenticular bodies in the sandstones. The clay is exposed at various places, viz., Pandhari, Nimbhora, Kherali,

Bairam and Belkher showing variability in colours, i. e., dirty white, grey, dark grey and black. However, dark grey coloured clays of Bairam and Belkher have been found to be productive for plant fossil remains. The generalised stratigraphy of the area is given in Table 1.

**Table 1—Generalised stratigraphy of the area.**

Age	Formation/Group	Lithology
Quaternary		Soil and alluvium
-----Unconformity-----		
Miocene to Late Cretaceous	Deccan Trap	Nonporphyritic to porphyritic basalt
-----Unconformity-----		
Late Cretaceous	Lametas	Shale, limestone and sandstone
-----Disconformity-----		
Early Cretaceous	Upper Gondwana	Clay, shale, sandstone and conglomerate
-----Unconformity-----		
Archaeans		Quartz-feldspathic gneiss

The present paper deals with the identification and detail description of the taxa. Since, all the recorded specimens



**Text-figure 1**—Geological map of the area (Srivastava *et al.*, 1995 after Gadewar & Sukhatankar, 1990).

are in the form of impressions, therefore, only morphological features have been taken into consideration. The comparison of the present assemblage has been made with other known

equivalent assemblages. An attempt has also been made for the correlation and assigning the age to the sequence. On the basis of recovered and known taxa, the interpretation of the

## PLATE 1

(Scale - one centimeter)

1. *Matonidium indicum* Sahnii 1936, detached pinnae showing oval elevations on either side of midrib.
2. *Taeniopteris spatulata* (McClelland 1850) incomplete leaf showing nature of lateral veins.
3. *Elatocladus* sp. A, sterile twig.
4. *Taeniopteris spatulata* (McClelland 1850) showing complete leaf.
5. *Matonidium indicum* Sahnii 1939, detached pinnae showing basal and middle portion.
6. *Elatocladus* sp. cf. *E. kingianus* sterile twig.
7. *Matonidium indicum* Sahnii 1939, fertile pinnae showing sori.
8. *Cladophlebis indicum* (Oldham & Morris) Sahnii & Rao 1933 showing venation pattern.
9. *Brachyphyllum* sp. leafy twig.

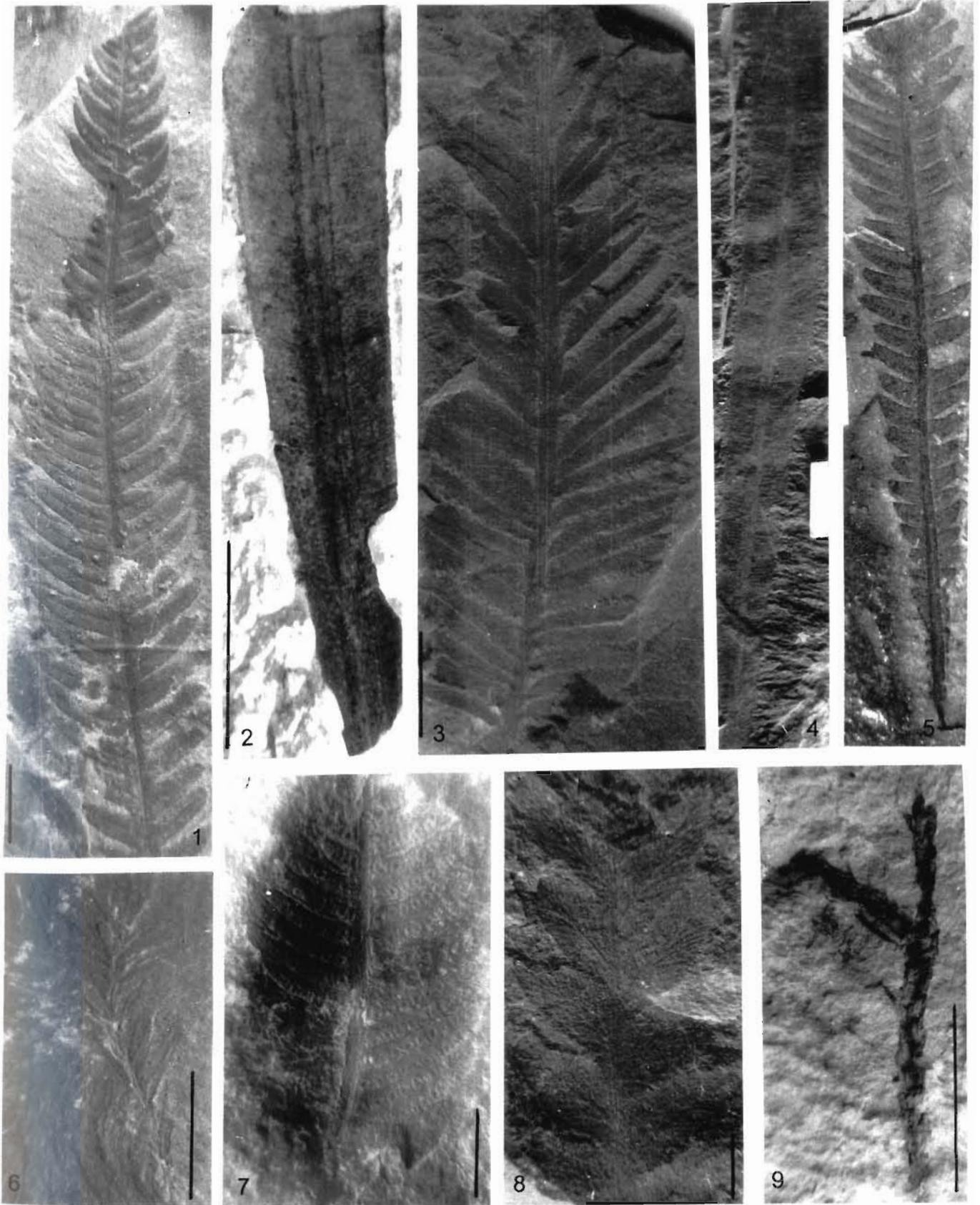
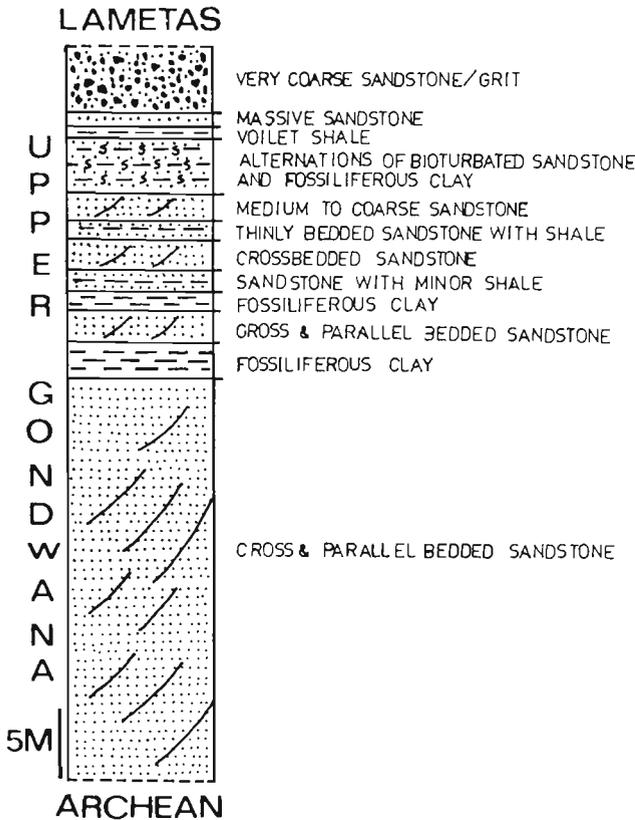


PLATE 1



Text-figure 2—Detailed sedimentary log of Gondwana succession of Bairam area.

palaeoclimate has also been made.

All the samples are kept in the museum of the P.G. Department of Geology, Amravati University, Amravati. The Bairam-Belkher area is approachable from Achalpur (Ellichpur in old records) via Nagpur at about 13 km on Betul road.

## SYSTEMATICS

### FILICALES

Genus—**MATONIDIUM** Schenk

**MATONIDIUM INDICUM** Sahni 1936

Pl. 1, figs 1, 5, 7

*Description*—Pinnately compound leaf, size 12-14 cm long and 2-3 cm wide. Pinna tends to become shorter at apex and wider towards base. Rachis 1.0-1.5 mm wide. Pinnules

about a cm long, 2-3 mm broad at base, slightly falcate, arranged suboppositely, attached by whole base to the rachis with an angle of about 50°-60°. Margin entire. Apex bluntly pointed, midrib distinct persisting upto apex. Veins arising from base nearly at right angle, once forked.

*Remarks*—This is a frequently recorded taxa in the field, however, our description is based on three part-counterpart and two almost complete specimens. The present specimen resembles *M. indicum* Sahni (1936; pl. 21, fig. 5; pl. 22 figs 1-4) from Himmatnagar and also *M. indicum* Kumaran *et al.* (1979; pl. 1, fig. 7) from Tarnetar in shape and venation pattern except for the slight variation in the size.

### UNCLASSIFIED FERN

Genus—**SPHENOPTERIS** Sternberg

**SPHENOPTERIS** sp.

Pl. 2, fig. 4

*Description*—Single specimen representing frond measuring 7 cm in length and 4.5 cm in width. Pinna rachis stout, 1.5 mm wide, pinnae arranged sub-oppositely with an angle of 45°-50°. Lamina of pinnae is lobed and contracted towards apex. Pinnules oval, alternately disposed, decurrent with rounded apex, margin entire, measuring 5-6 mm, wide at base. Veins arising from the base and diverging to its apex, forked atleast once.

*Remarks*—The present specimen is identical to *Sphenopteris hislopi* (Surange, 1964, fig. 73) from Rajmahal Hills but differ in the size of the pinna and angle of the attachment to the rachis. Difference in the venation pattern and shape of the pinnules has also been noticed while comparing with *S. rajmahalensis* (Surange, 1964, fig. 74). Our specimen also resembles *Sphenopteris* sp. (Bose *et al.*, 1979, fig. 2B) but differs in having pinnules with finer veins.

Genus—**CLADOPHLEBIS** Brongniart

**CLADOPHLEBIS INDICA** (Oldham & Morris)

Sahni & Rao 1933

Pl. 1, fig. 8

*Description*—Two incomplete specimens with counterparts showing pinnately compound leaf having length 8-9 cm and width 1.5-2 cm, rachis 1 mm broad. Pinnules 1.0-1.2 cm long, about 0.3-0.4 cm broad near base, alternately attached at an angle of 40°-50°. Apex subacute, margin entire, midrib

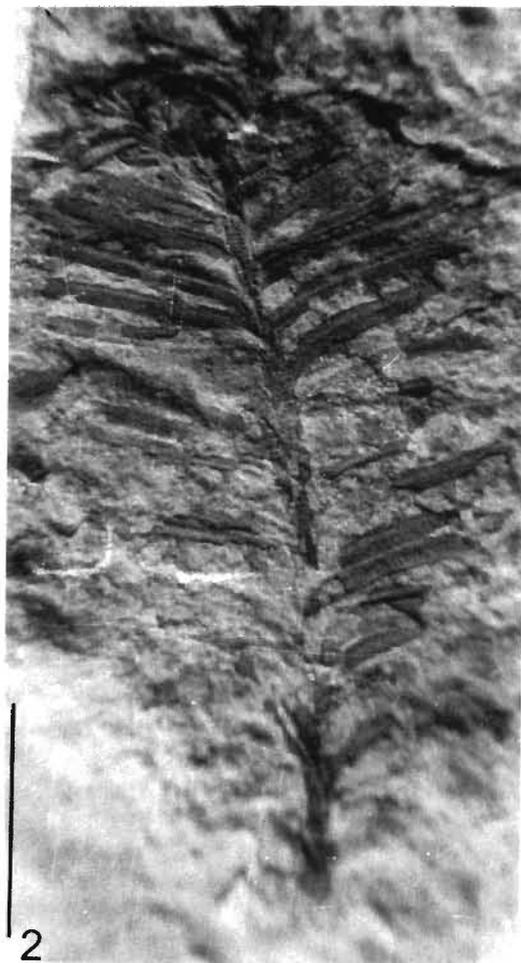
## PLATE 2

(Scale - one centimeter.)

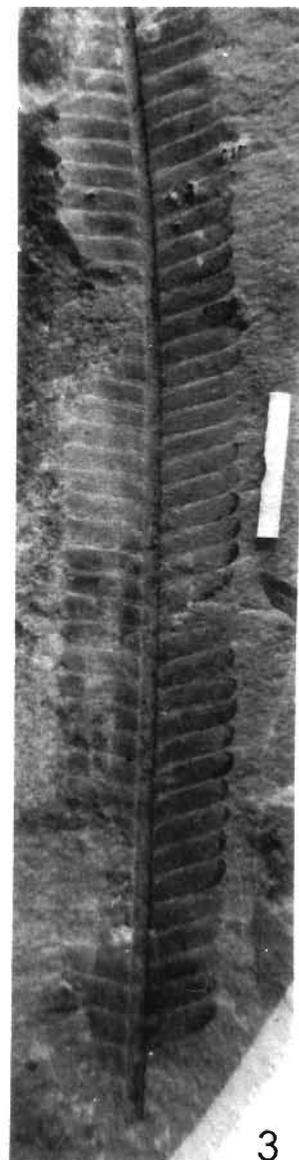
1. *Pagiophyllum* sp. showing arrangement of leaf.
2. *Elatocladus tenerrima* (Feistmantel) Sahni 1928 showing arrangement of leaves and midrib.
3. *Ptilophyllum cutchense* Morris 1840 showing distinct midrib and arrangement.
4. *Sphenopteris* sp. showing venation pattern.
5. *Cladophlebis indicum* (Oldham & Morris) Sahni & Rao 1933 showing details of pinnules (scale 0.5mm).



1



2



3



4



5

PLATE 2

prominent, persisting up to the apex. Veins arising at an angle of 30°-35° from the midrib, mostly forked, reaching up to margin.

*Remarks*—Our specimen resembles *Cladophlebis indica* (Oldham & Morris) Sahní and Rao 1933 described by Banerji (1990; pl. 1, fig. 4) from Dubrajpur Formation.

### BENNETTITALES

Genus—PTILOPHYLLUM Morris

PTILOPHYLLUM CUTCHENSE Morris 1840

Pl. 2, fig. 3; Pl. 3, fig. 3

*Description*—About a dozen specimens are present in the collection. Leaves pinnately compound, size varies from 14-16 cm in length and 2.0-3.0 cm in width, rachis 0.1 cm wide. Pinnules 0.6-0.7 cm long, 1.5-2.0 mm broad, closely arranged, opposite to suboppositely attached on the upper surface of the rachis by whole base, apex obtuse, acroscopic margin curved rounded, basiscopic margin almost straight. Veins parallel, nearly 4-6 veins arises from the base, simple or forked.

*Remarks*—The present specimen resembles *P. cutchense* of Banerji (1990; pl. 1, fig. 6) reported from the Lower Cretaceous of Dubrajpur except the smaller size of the pinnules; *P. cutchense* of Bose *et al.* (1982; pl. 1, fig. 6) from the Gollapalle Formation. It is one of the frequently occurring taxa in the study area.

PTILOPHYLLUM ACUTIFOLIUM Morris 1840

Pl. 3, fig. 2

*Description*—Four incomplete specimens of pinnate leaves are present. Size varies from 5-6 cm in length and 2-3 cm in width. Pinnules 1.5-2.0 cm long, 2 mm broad at the base, closely set, suboppositely attached by whole base on the upper surface of 1 mm wide rachis with an angle of 45°-50°. Apex acute, acroscopic margin curved downward, basiscopic margin straight. Venation parallel, 7-8 veins arising from base, simple or forked.

*Remarks*—Frequency of the species is comparatively less than *P. cutchense* Morris in the present assemblage. It shows resemblance with *P. acutifolium* reported by Pandya and Sukh-Dev (1990; pl. 1, fig. 8) from Lower Cretaceous of Gollapalle Formation and the specimen of *P. acutifolium* recorded by Banerji (1990; pl. 1, fig. 8) from Lower Cretaceous of Dubrajpur.

### CYCADALES

Genus—TAENIOPTERIS Brongniart

TAENIOPTERIS SPATULATA McClelland 1850

Pl. 1, figs 2, 4

*Description*—Six incomplete specimens showing simple, linear lanceolate leaves, size varies from 13.5-14.0 cm in length and 1.4 cm in width. The width of lamina increases gradually from the base and tapers towards apex. Apex obtuse, margin entire, midrib prominent, 2-3 mm wide distinct up to apex. Veins simple, parallel or forked arising from the midrib with an angle of 84°-87°. Vein concentration 22-25 per cm.

*Remarks*—The specimen matches with *T. spatulata* of Pandya and Sukh-Dev (1990; pl. 1, fig. 4) from Lower Cretaceous of Gollapalle Formation.

TAENIOPTERIS sp. cf. T. VITTATA Brongniart

Pl. 3, fig. 1

*Description*—Leaf simple, 3.5 cm in length and 2.5-3 cm in width. Lamina thin, margin appears to be entire, midrib 2 mm thick. Lateral veins originating from midrib making an angle of 85°-88°, simple or forked once. Concentration of veins 30-35 per cm.

*Remarks*—Both the recovered specimens show only middle portion of the leaf. Margin of lamina is poorly preserved. Venation distinct at places. However, on the basis of only a few observable characters i. e., parallel lateral venation and shape of the lamina, it is comparable with *T. vittata* of Seward (1991; fig. 332). The specimen is also comparable with the photograph of *T. vittata* of Pascoe (1959; Jabalpur flora) in respect of lamina width and parallel venation.

### CONIFERALES

Genus—PAGIOPHYLLUM Heer

PAGIOPHYLLUM sp.

Pl. 2, fig. 1

*Description*—Leafy twigs, 3 cm long and 1 cm wide, irregularly branched, branches 7-9 mm long and 2-2.5 mm wide, emerging at an angle of 40°-45°. Leaves 2 mm long and about 1 mm wide, spirally arranged, closely set, spreading with different angles, apex acute, margin entire.

*Remarks*—There are three specimens with one counter part. It is closer to *P. peregrinum* (L. & H) Schenk, Sahní (1928; pl. III, fig. 43), *P. sherensis* Maheshwari *et al.*, (1976; pl. 2, fig. 8), *P. marwarensis*, Bose *et al.*, (1982; pl. 1, figs 9, 12) in their external characters, reported from Jurassic and Lower Cretaceous bed of India. However, they differ in size and angle of branching. They also resembles *P. gollapallensis* of Pandya and Sukh-Dev (1990; pl. 1, fig. 7; pl. 2, fig. 15) except the arrangement of leaves and their size. Due to lack of epidermal characters, the exact comparison is not possible.

BRACHYPHYLLUM Brongniart

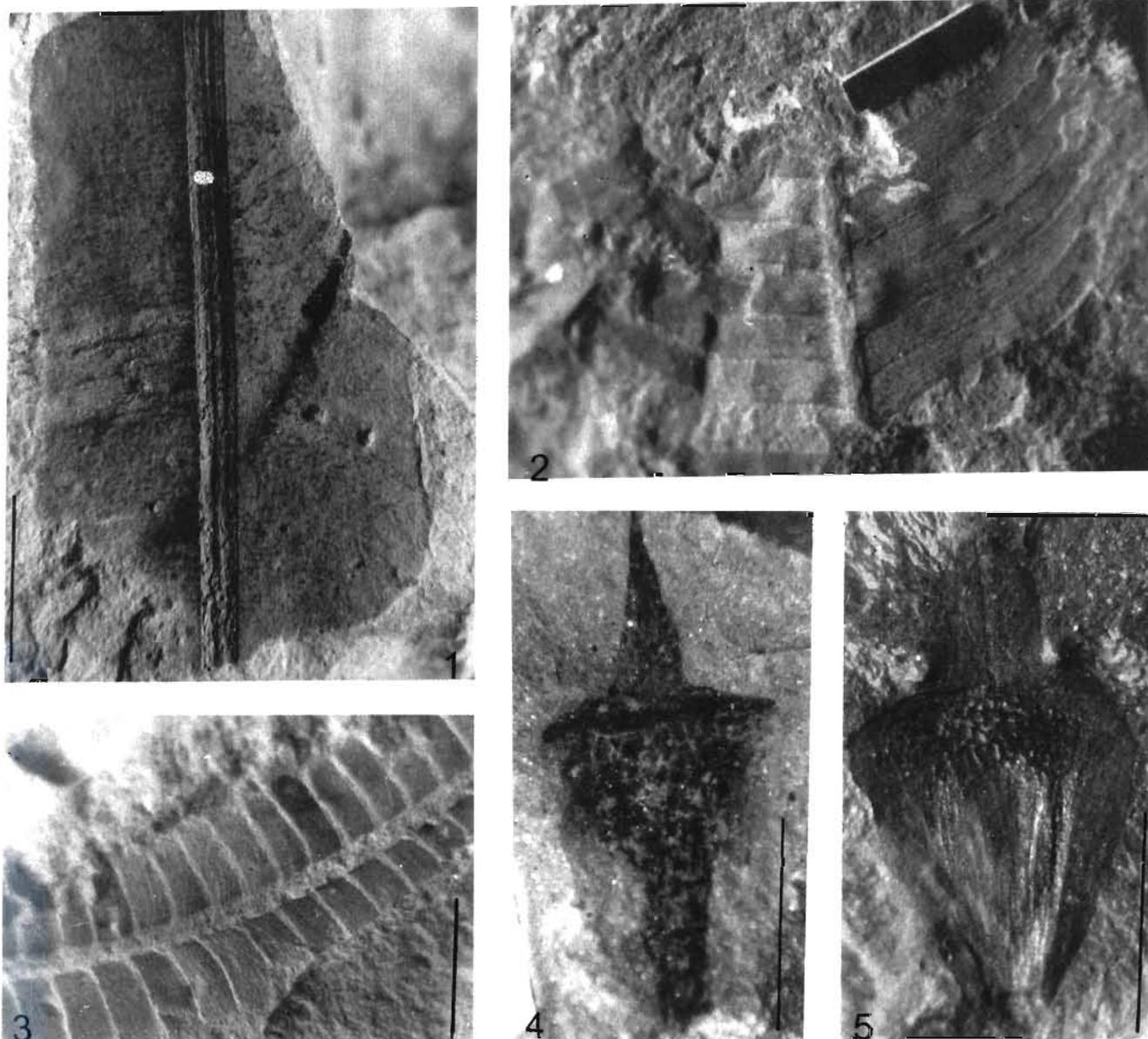
BRACHYPHYLLUM sp.

Pl. 1, fig. 9

*Description*— Solitary leafy twig, branched, 4 cm in length and 3 cm in width, branching at an angle of  $50^{\circ}$ - $56^{\circ}$ . Rhomboidal leaves, closely arranged, margin appears to be entire, apex acute.

*Remarks*—The specimen is closer to *B. rhombicum*

(Feist.) Sahni (1928; pl. 2, fig. 23) from South Rewa, Madhya Pradesh but differs in size and arrangement of the leaves. It also shows similarity with *Brachyphyllum* sp. described by Bose *et al.*, (1979; pl. 1, fig. 20) but exact comparison is not possible due to poor preservation.



### PLATE 3

(Scale - one centimeter.)

1. *Taeniopteris* sp. cf. *T. vittata* Brongniart showing distinct midrib and venation pattern.
2. *Ptilophyllum acutifolium* Morris 1840 showing arrangement of leaf and venation pattern.
3. *Ptilophyllum cutchense* Morris 1840 showing distinct rachis and venation pattern (scale - 0.5 cm).
4. *Araucarites* scale leaf.
5. *Araucarites cutchense* Feistmantel 1876, scale leaf showing site of ovule attachment.

Genus—**ARAUCARITES** Presl. 1838

**ARAUCARITES CUTCHENSE** Feistmantel 1876

Pl. 3, figs 4 & 5

*Description*—Detached seed scale. 2.4 cm long, 1.4 cm broad, truncated base 4 mm wide, rounded to subrounded tip, seed ovate, surface of the scale showing fine longitudinal striations, middle part of scale showing shallow depression of seed measuring 10 x 5 mm.

*Remarks*—The described specimen closely matches with *A. cutchense* from Jabalpur (Sahni, 1928; pl. V, fig. 67) and the specimen reported from the Lower Cretaceous of Tarnetar, Gujarat (Kumaran *et al.*, 1979, pl. 1, figs 11 & 12).

Genus—**ELATOCLADUS** Halle

**ELATOCLADUS TENERRIMA** (Feistmantel)

Sahni 1928

Pl. 2, fig. 2

*Description*—Single branched leafy twig, axis about 1 mm thick. Linear leaves 0.8-1.0 cm long, approximately 1 mm broad, uniformly from base to apex. Leaves spirally, biserially arranged in one plane diverging at wide angle from axis, measuring 70°-80°, attached by entire width of decurrent leaf base. Apex obtuse, margin entire, midrib obscure, visible at one or two places, persisting up to apex.

*Remarks*—Presence of linear and usually straight leaves having obtuse apex and strongly decurrent base giving off at wide angle shows that the present specimen belongs to *E. tenerrimus* (Feistmantel) which was described by Sahni (1928; pl. 1, figs 10, 11) but their cuticular features are not known.

**ELATOCLADUS** sp. cf. **E. KINGIANUS**

Pl. 1, fig. 6

*Description*—Solitary slender leafy twig with axis 1 mm wide, leaves narrow, linear-lanceolate, 5-6 mm long, 0.5 mm broad, spirally arranged, spreading out in two rows irregularly at different angles in one plane. Base contracted, apex acute, margin entire, mid-vein faintly marked.

*Remarks*—Present specimen shows morphological resemblance with *E. heterophylla* Halle (Seward, 1919; vol. IV, fig. 801) from Grahamland and *E. selhoraensis* of Maheshwari and Kumaran (1976; pl. 1, fig. 4) from the Jabalpur Group. It is more akin to *E. kingianus* of Bose *et al.*, (1982; pl. 1, fig. 10) in size, shape and apex of the leaves.

**ELATOCLADUS** sp. A

Pl. 1, fig. 3

*Description*—Leafy twig, 5 cm long and 2 cm broad, axis of the twig 1.5 mm wide. Leaves linear-lanceolate, 14 mm in length and 1-1.5 mm in width, arranged in close spiral,

laterally spread in one plane, attached at an angle of 50°-60°. Leaf base contacted, decurrent. Apex obtuse pointed, margin entire, midrib distinct from base to apex.

*Remarks*—Present specimen matches with *E. conferta* (O & M) Sahni (1928) in the shape of the leaves and angle of the attachment. It also shows resemblance with *E. tenerrimus* Sahni 1928 and *E. pseudotenerrima* described by Maheshwari and Kumaran (1976) but differs in well spread out leaves and apex.

## DISCUSSION AND CONCLUSIONS

A total of thirteen taxa viz., *Matonidium indicum*, *Sphenopteris* sp., *Cladophlebis indica*, *Ptilophyllum cutchense*, *P. acutifolium*, *Taeniopteris spatulata*, *T. vittata*, *Pagiophyllum* sp. *Brachyphyllum* sp. *Araucarites cutchense*, *Elatocladus tenerrima*, *Elatocladus* sp. cf. *E. kingianus* and *Elatocladus* sp. A have been described for the first time from a new locality of Bairam-Belkher area of district Amravati, Maharashtra and district Betul, Madhya Pradesh. The plant fossils are preserved in the form of leaf impressions in the clay horizons. These clays are in the form of lentils or pockets, interbedded with medium to coarse grained sandstones.

The assemblage is dominated by Bennettitales followed by Filicales, Cycadales, Coniferales and unclassified ferns. *Ptilophyllum* and *Matonidium* are the two most dominant genera in the assemblage.

Regarding the age and equivalence, the sequence was a matter of debate. Earlier workers have correlated it with Triassic on the basis of non-palaeontological criteria (Pascoe, 1959; Adyalkar, 1975; Bhusari, 1979) while Kumar (1990) considered it Neocomian-Aptian on the basis of the palynological studies. Recently, Srivastava *et al.*, (1995) have assigned it Lower Cretaceous age on the basis of megafossil remains.

The assemblage has been compared with the known assemblage from the Upper Gondwana succession of Peninsular India ranging in age from Upper Jurassic to Lower Cretaceous (Table 2). Most of the taxa presently reported are individually less significant for assigning the age because of their wide records from Upper Jurassic to Lower Cretaceous horizons. However, presence of Conifers viz., *Pagiophyllum*, *Brachyphyllum*, *Elatocladus* and *Araucarites* show affinity with Lower Cretaceous age. The dominance of *Ptilophyllum* is also comparable with Upper Jurassic to Lower Cretaceous assemblages of Dubrajpur and Jabalpur Formations. *Matonidium* has been found to be one of the most commonly recorded taxa and is comparable with the Lower Cretaceous assemblage of Himmatnagar showing dominance of the same (Sahni, 1936). Considering the overall assemblage, i. e., diversity of Coniferales, dominance of Bennettitales and Filicales, it has been assigned Lower Cretaceous age which also supports the Neocomian-Aptian age as proposed by Kumar (1990) on the basis of the pollen and spores.

Table 2—Comparison of the present fossil assemblage with other localities of Peninsular India ranging in age from Late Jurassic to Early Cretaceous.

Taxa/Locality	Present assemblage	Dubrajpur (Late Jura. to Early Cret.) (Banerji 1990)	Gardeshwar (Early Cret.) (Bose <i>et al.</i> , 1979)	Gangapur (Early Cret.) (Bose <i>et al.</i> , 1982)	Gollapalle (Early Cret.) (Pandya & Sukh Dev 1990)	Himmatnagar (Cret.) (Banerji <i>et al.</i> , 1979)	Jabalpur (Late Jura. to Early Cret.) (Pascoe 1959, 1991; Bose <i>et al.</i> , 1966)	Tarnetar (Early Cret.) (Kumaran <i>et al.</i> , 1979)	Umia (Early Cret.) (Pascoe 1959; Shah <i>et al.</i> , 1991)
<i>Matonidium indicum</i>	Abundant	-	-	-	-	Abundant	-	+	+
<i>Sphenopteris</i> sp.	+	-	+	-	-	+	Common	-	-
<i>Cladophlebis indica</i>	+	+	+	+	+	Common	Common	Common	+
<i>Ptilophyllum cutchense</i>	Abundant	+(*)	-	+	+	-	+	-	+
<i>P. acutifolium</i>	+	+(*)	-	+	+	-	Common	-	+
<i>Taeniopteris spatulata</i>	Common	+(**)	-	+	+	-	Common	-	+
<i>T. vittata</i>	+	+(**)	-	-	-	-	+	-	+
<i>Pagiophyllum</i> sp.	+	+	Abundant	+	+	+	+	-	+
<i>Brachphyllum</i> sp.	+	-	Abundant	-	+	-	+	-	+
<i>Araucarites cutchense</i>	+	-	+	+	+	+	+	+	+
<i>Elatocladus tenerrimus</i>	+	-	+	+(**)	+	-	+	-	+
<i>Elatocladus</i> sp. cf. <i>E. kingianus</i>	+	-	-	+(**)	-	-	+	-	-
<i>Elatocladus</i> sp. A	+	-	+	+(**)	-	-	+	-	-

+ Present; - Absent; \* Sp. level not specified; \*\* Information up to genus level.

It has been summarised that the climate was warm and humid as interpreted on the basis of the luxuriant growth of Bennettitales and Cycadales (Ramanujam, 1979). The dominance of the cycadophytes also suggests the prevalence of tropical to subtropical climate during the sedimentation as has been proposed for the Dubrajpur Formation of Lower Cretaceous age by Banerji (1990). The palynological studies of Kumar (1990) also supports the existence of the warm and humid climate. The present palaeoclimatological interpretation also coincide with the generalised interpretation of Surange (1964) of warm and humid climate during Lower Cretaceous to Eocene age.

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