THE GANGAPUR FORMATION : FOSSIL FLORA AND STRATIGRAPHY

SUKH-DEV & A. RAJANIKANTH

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

Abstract

The present paper deals with morphotaxonomic studies of the fossil flora from the Gangapur Formation, Andhra Pradesh. In this floral assemblage conifers are the dominant elements, cycadophytes are quite common and pteridophytes have less representation. The pteridosperms are rare. The assemblage comprises the genera *Cladophlebis*, *Pachypteris*, *Taeniopteris*, *Ptilophyllum*, *Dictyozamites*, *Elatocladus*, *Pagiophyllum*, *Brachyphyllum*, *Allocladus*, *Araucarites* and *Coniferocaulon*, in which three new species, one each of *Pachypteris*, *Dictyozamites* and *Pagiophyllum* are recorded. In view of the present findings and other evidences the age of the Gangapur Formation is considered Early Lower Cretaceous.

Introduction

The Gangapur Formation has been recognised in the vicinity of the village Gangapur (19°16′, 79°26′) in Adilabad District, Andhra Pradesh and named after this village by Kutty (1969) for the beds previously referred to as Gangapur beds by King (1881) under the Kota Formation. The Gangapur formation extends a few kilometres north of Nowgaon (19°20′, 79°24′) and to the west of Gangapur Village, and in the east upto Dharmaram and Paikasigudem. This Formation is considered to be the youngest Gondwana unit of the Pranhita-Godavari Valley overlain by the trap flows/?Chikiala beds.

Geology—King (1881) considered the Gangapur beds to form the basal member of the Kota Formation However, the actual contact of Gangapur beds with the underlying beds observed at two places, one at a stream section about half a kilometre northeast of Paikasigudem and the other in Gangapur cliffs. The sandstones exposed in these cliffs form basal beds of this Formation. Thus the Gangapur beds uncomformably overlie the Kota beds and are in turn overlain by the trap flows (Kutty, 1969). The relationship of the Gangapur Formation with the Chikiala Formation is not exactly known. Rudra (1972) recognised the Gangapur Formation in the eastern part of the outcrop around Yamanapalli Village and suggested that the stratigraphic position of these beds is in between Kota and Chikiala beds. Kutty (1969) noticed an apparent coarsening of Gangapur sediments eastwards and if this trend is not local, there is possibility that Gangapur Formation may be equivalent to the Chikiala Formation. Recently Raiverman (1986) while studying sedimentation frame-work within the Pranhita-Godavari Basin considered Gangapur sediments to be overlain by Chikiala beds.

The Gangapur Formation is characterized by yellow, light brown and buff sandstones, conglomerates with clayey interbeds.

---

*This paper was presented in the *Special Indian Geophytological Conference* held in November 27-29, 1986 at the Department of Botany, University of Poona, Pune 411 007.

Faunal Evidences—Faunal evidences from the Gangapur Formation are very little known. Only a unionid and some ganoid fish scales are known (Kutty 1969).

Palaeobotany—The palaeobotany of Gangapur Formation is not much known. Most of the 'Kota Flora' actually belongs to this Formation. The megaflora of these beds were recorded by Fesitmantel (1879), King (1881), Sahni (1928), Mahabale (1967), Tripathi (1975), Ramanujam and Rajeshwar Rao (1979), Rajeshwar Rao (1979), Bose, Kutty and Maheshwari (1982), Rajeshwari Rao, Ramanujam and Varma (1983) and Pal, Ghosh, Datta and Shome (1985). However, systematic descriptions of some of the plant fossils were given by Sahni (1928), Bose *et al.* (1982) and Ramakrishna & Muralidhar Rao (1986).

Palynology of Gangapur sediments was worked out by Shah and Gopal Singh (1974), Rajeshwar Rao and Ramanujam (1979), Ramanujam and Rajeshwar Rao (1979, 1980), Bose, Kutty and Maheshwari (1982), Rajeshwar Rao, Ramanujam and Verma (1983) and Ramakrishna and Muralidhar Rao (1986).

Fossiliferous Localities—The fossiliferous localities of Gangapur Formation are known since long. Feistmantel (1879) reported plant fossils from Chirakunta and Nowgaon localities, King (1881) too noted plant remains of Gangapur beds at three places near Nowgaon, Chirakunta and between the villages Moar and Balhanpur. Likewise Sahni (1928), Mahabale (1967), Tripathi (1975) and Rajeshwari Rao *et al.* (1983) also reported plant fossils from various localities of Gangapur Formation. Bose, Kutty and Maheshwari (1982) described some plant fossils from Nowgaon, Gangapur, Anksapur, Moar and Butarmal Nala areas. Ramakrishna and Muralidhar Rao (1986) reported *Pterophyllum medlicottianum* from Anksapur. For the present study plant fossils belonging to the following localities were collected in the Adilabad district, Andhra Pradesh during the field seasons of 1982 and '83.

Nowgaon (19°20′-79°24′)—This village lies about three kilometres northeast of Ralapet Village (Map-1). Two quarries about one kilometre south-east of the village yielded plant impressions preserved in pinkish and ash coloured clays. The conifers are the dominant elements at this locality.

Ralapet (19°19′-79°25′)—About half a kilometre west northwest of the village Ralapet (Map 1), two quarries yielded plant fossils preserved in whitish and grey clay shales, which are overlain by sandstones and recent alluvium. At this locality also conifers are dominent.

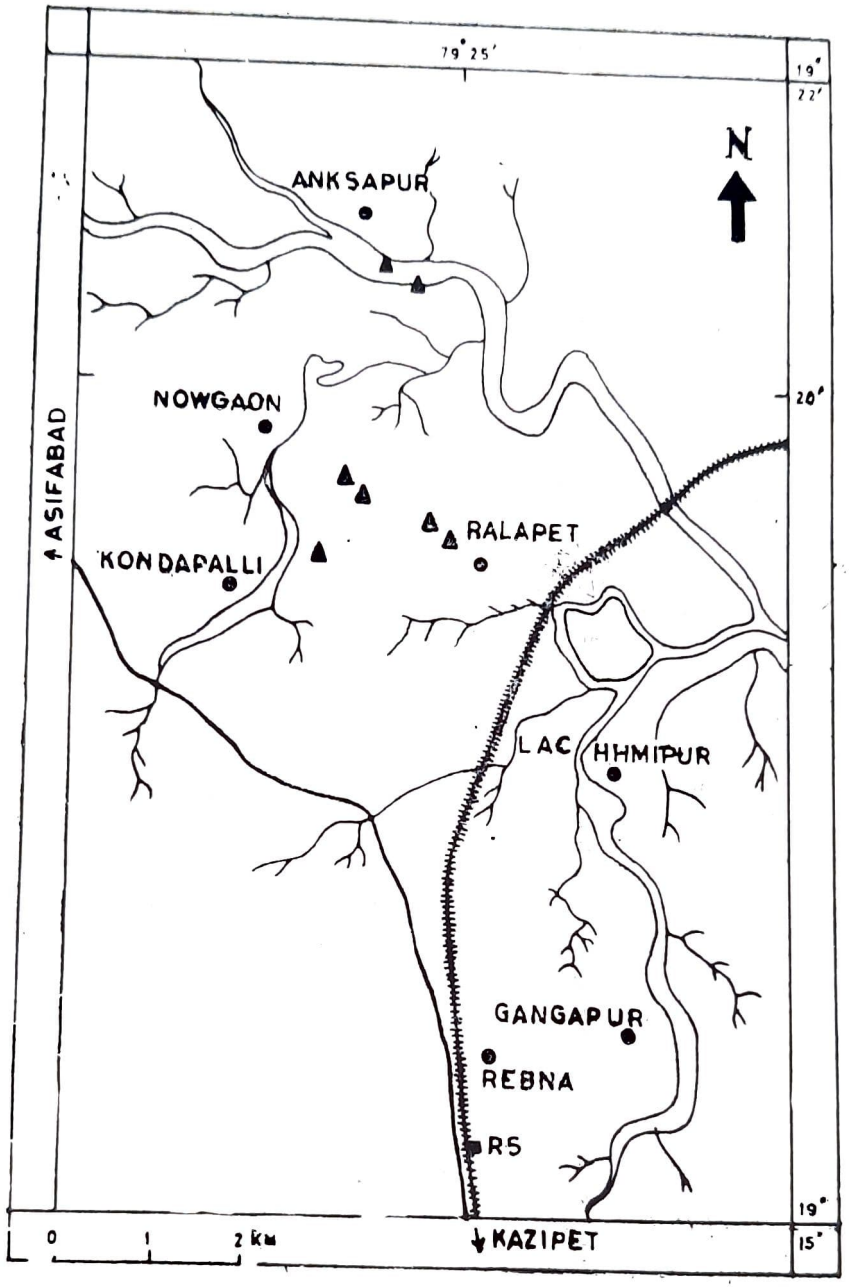
Kondapalli (19°19′-79°24′)—Plant fossils are preserved in pinkish and whitish clay beds in a quarry about half a kilometre east of the Kondapalli Village (Map 1). The conifer elements are dominant here.

Butarmal Nala (19°26′-79°11′)—A small outcrop near a bridge on the bank of Butarmal Nala, 13 km WNW of Asifabad (Map 2) yielded plant compressions. The exposed bed is about two feet thick. It consists of the following lithology in the descending order (A-C) :

A 3″-9″	Yellowish clay shale
B 2″-8″	grey clay
C 3″-8″	black shale

At this locality the cycadophytes are fairly well-represented.

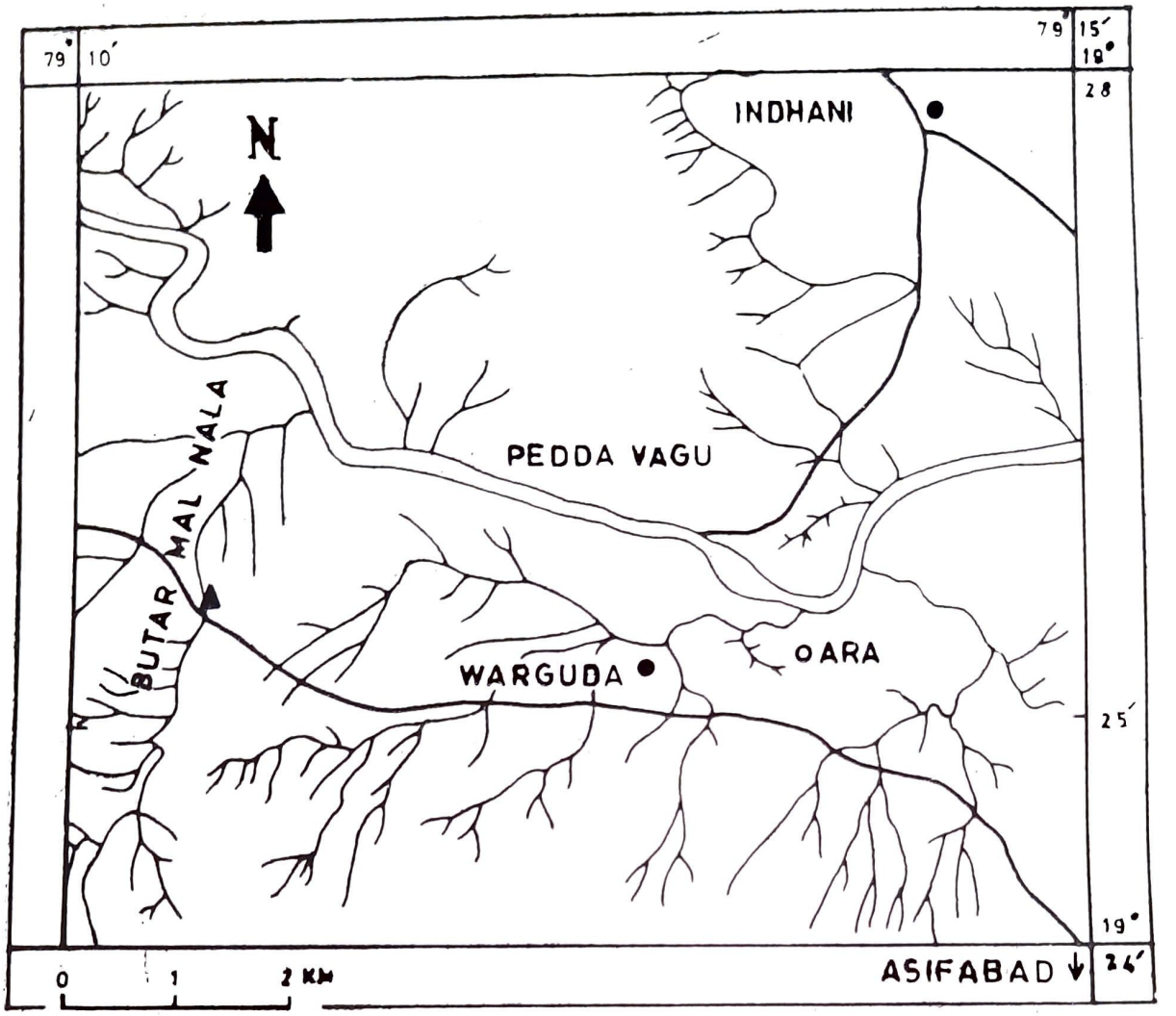
Age of Gangapur Formation—Authentic faunal evidences from the Gangapur Formation are lacking. Hence one has to mostly depend upon floral evidences. The fossil flora of the Gangapur Formation was considered to be intermediate in age between



Map 1—Showing plant fossil localities (▲) in Adilabad District, Andhra Pradesh.

Rajmahal and Jabalpur floras (Feistmantel 1879, King 1881). Pascoe (1959) suggested an Upper Jurassic age to this flora. Kutty (1969) while discussing the age of Gangapur beds suggested an Early Lower Cretaceous age. Shah, Gopal Singh and Gururaja (1973) have suggested that the age of Gangapur Formation may be any where between Middle Jurassic to Lower Cretaceous (Upper Neocomian). These are the main views regarding the age of the Gangapur Formation. However, recent workers consider the age Lower Cretaceous (Neocomian-Aptian).

Though the flora of Gangapur Formation has been studied by a number of palaeobtanists, yet it is far from being adequately known. In order to know more about the plants of this Formation two excursions have been undertaken to Andhra Pradesh during February 1982 and Febraruy-March 1983 and a number of plant fossils have been collected from new as well as known localities. These plants have



Map 2—Showing plant fossil localities (▲) in Butarmal Nala in Adilahad District, Andhra Pradesh.

been morphotaxonomically studied and illustrated in this paper. The data thus obtained has been analysed in the light of faunal and stratigraphical evidences available on the Gangapur Formation.

Description

UNCLASSIFIED FERNS

Genus—*CLADOPHLEBIS* Brongniart 1849

Cladophlebis sp.
Pl. 1, fig. 2; Text-fig. 1A

Description—Pinna fragmentary, measuring 1.0×1.2 cm. Rachis slender, 1 mm wide Pinnules alternate, closely set, broader at base and narrowing towards distal end, available length 6 mm and breadth 3 mm, attached to rachis by entire base at an angle of 75°-85°. Margin entire. Venation distinct. Midrib prominent, lateral veins catadromic, forking once, making an angle of about 50°-70°.

Collection—B. S. I. P. Museum Specimen no. 36183.

Locality—Nowgaon, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Comparison—*Cladophlebis* sp. somewhat resembles in shape sterile pinnule of *Todites indicus* (Oldham & Morris) Bose and Sah (1968) and *Cladophlebis* sp. cf. *C. longipennis* Seward described by Bose (1958) and Roy (1968). In *T. indicus* secondary veins may be forked twice, whereas in *C.* sp. cf. *C. longipennis* pinules are rhomboidal in shape and comparatively more inclined forward. *Cladophlebis* sp. is somewhat comparable in general appearance with *Todites goeppertianus* (Muenst.) Krasser (Oishi, 1940) and *Cladophlebis oblonga* Halle (1913). The venation pattern in *T. goeppertianus* is not known. In *C. oblonga* the secondary veins may be twice forked. In *Cladophlebis* sp. the secondary veins are once forked.

PTERIDOSPERMALES

Family—CORYSTOSPERMACEAE

Genus—*PACHYPTERIS* Brongniart 1828

Pachypteris gangapurensis n. sp.
Pl. 1, figs. 3, 4, 5, 7, 8 ; Text-fig. 1 B-E

Diagnosis—Leaf bipinnate, incomplete, measuring up to 4.5 cm in length and 2.5 cm in width. Rachis longitudinally grooved, 1-1.5 mm wide. Pinnae alternate, 1.5-2 cm long. 0.6-0.7 cm wide, making an angle of about 38°-40° to pinna rachis. Pinna rachis about 1 mm wide, longitudinally grooved. Pinnules closely set, small, alternate, lanceolate to obovate, 3.5-6 mm long. 1-2 mm wide, apical pinnule usually larger, substance of lamina moderately thick,, margin entire, basiscopic basal margin decurrent along rachis, apex obtuse, sometimes broadly rounded, Veins concealed.

Cells of rachis rectangular or squarish, some polygonal, anticlinal wall 2-2.5 μm thick, straight, at places slightly wavy or curved, end walls sometimes oblique, periclinal wall unspecialized.

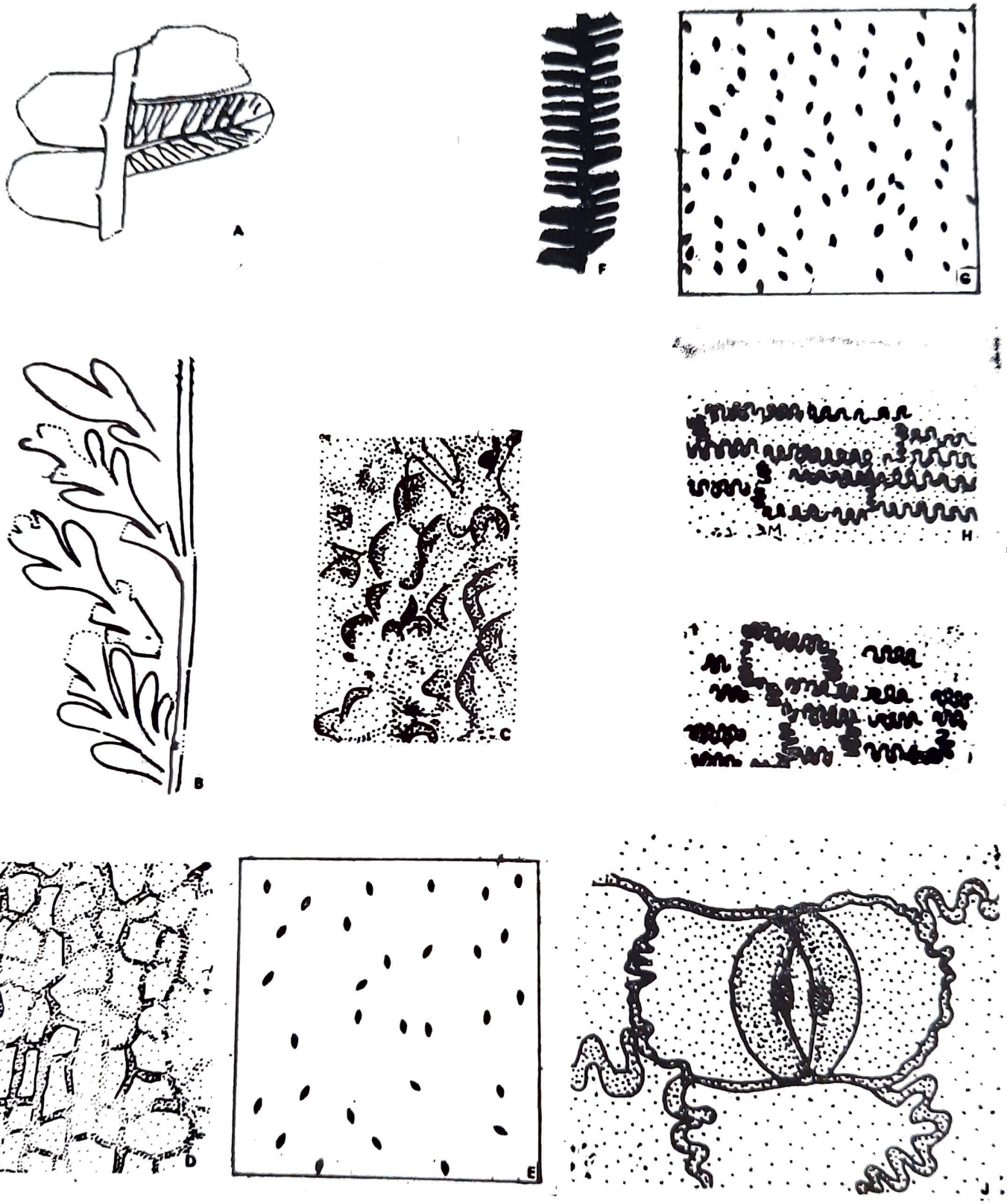
Leaf hypostomatic, upper cuticle 4-5 μm thick (in folds), slightly thicker than the lower. Cells on upper surface polygonal, squarish or sometimes rectangular, periclinal walls smooth or at places thickened and appear papillate, anticlinal wall thick, straight or slightly curved, Cells on lower surface polygonal, as long as broad or slightly longer, periclinal wall smooth or thickened into variously shaped small papillae. Papillae at some places more concentrated. Cells over veins rectangular, narrow, serially placed. Stomata irregularly scattered and oriented, avoiding veins. Stomatal apparatus circular to oval, subsidiary cells 6-8 (mostly 5 or 6), less cutinised than ordinary epidermal cells, anticlinal walls around stomatal pit slightly raised. Guard cells sunken, thinly cutinised.

Holotype—B. S. I. P. Museum Specimen no. 36184.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formatin, Early Cretaceous.

Comparison—*Pachypteris gangapurensis* resembles *P. indica* (Oldham & Morris) Bose & Roy (1968) in having bipinnate leaves. *P. indica* has long, narrow and non-papillate pinnules, whereas in *P. gangapurensis* pinnules are smaller, lanceolate to obovate and papillate. Some leaves in *P. specifica* Fesitmantel described by Bose



Text-figure 1—**A,** *Cladophlebis* sp., specimen no. P. S. I. P. 36183, ×4 ; **B-E,** *Pachypteris gangapurensis* n. sp. ; **B**, holotype, specimen no. B. S. I. P. 36184 B, ×2 ; **C,** lower cuticle showing papillae, slide no. B. S. I. P. 36184-I, ×250 ; **D,** cells of lower cutcle, slide no.B. S. I. P. 36184-I, ×150 ; **E,** lower cuticle showing distribution and orientation of stomata in 1 sq mm, slide no. B. S. I. P. 36184-I, ×40. **F-J,** *Ptilophyllum distans* (Feistm.) Jacob & Jacob ; **F,** leaf, specimen no. B. S. I. P. 36184 × 1; **G.** lower cuticle showing distribution and orientation of stomata in 1 sq mm slide, no. P. S I. P. 36190-I, ×40 ; **H** lower cuticle, slide no. B. S. I. P. 36190-I, ×150 ; **J** a stoma magnified, slide no. B. S. I. P, 36190-I. ×500.

and Banerji (1984) do resemble *P. gangapurensis* in shape and size of the pinnules but they are non-papillate. *P. gangapurensis* resembles *P. lanceolata* Brongniart described by Harris (1964) in general morphological characters. In *P. gangapurensis* leaves are papillate unlike *P. lanceolata* where within strips and striations are present on epidermal cells. *P. gangapurensis* also comes closer to *P. papillosa* (Thomas & Bose Harris (1964) in having papillate leaves. However, in both the species leaves are quite different in the shape and size of pinnules and also in the details of stomatal structure. *P. gangapuresnsis* closely matches *P. crassa* (Halle) Townrow (1965) in general morphology of leaves which are also papillate. However, both the species differ from each other in the details of stomata. In *P. crassa* subsidiary cells unlike *P. gangapurensis* are papillate. Moreover, in the former species papillae are abundant on both the surfaces.

CYCADALES

Genus—*TAENIOPTERIS* Brongniart 1832

Taeniopteris spatulata McCleland
Pl 1, fig. 1 ; Text-fig. 2 A. B.

1982 *Taeniopteris* sp. of. *T. spatulata* McClelland : Bose, Kutty & Maheshwari, p. 124, pl. 2, fig. 18, test-fig. 2E-G.

Description—Leaves simple, narrow, strap-shaped, maximum available length 9 cm and width at broadest point 1 cm, narrowing towards base and apex. Margin entire. Apex acute. Midrib 1 mm wide, at places longitudinally striated. Lateral veins arising at wide angle of about 70°-90°, mostly simple, some forking once just after emergence or forking at some distance, rarely one of the arms forked again, parallel, about 28-31 veins per cm reaching margin.

Collection—B. S. I. P. Museum Specimen nos. 36185, 34/2975B, 71/2975 B and 80/2975B.

Locality—Ralapet and Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

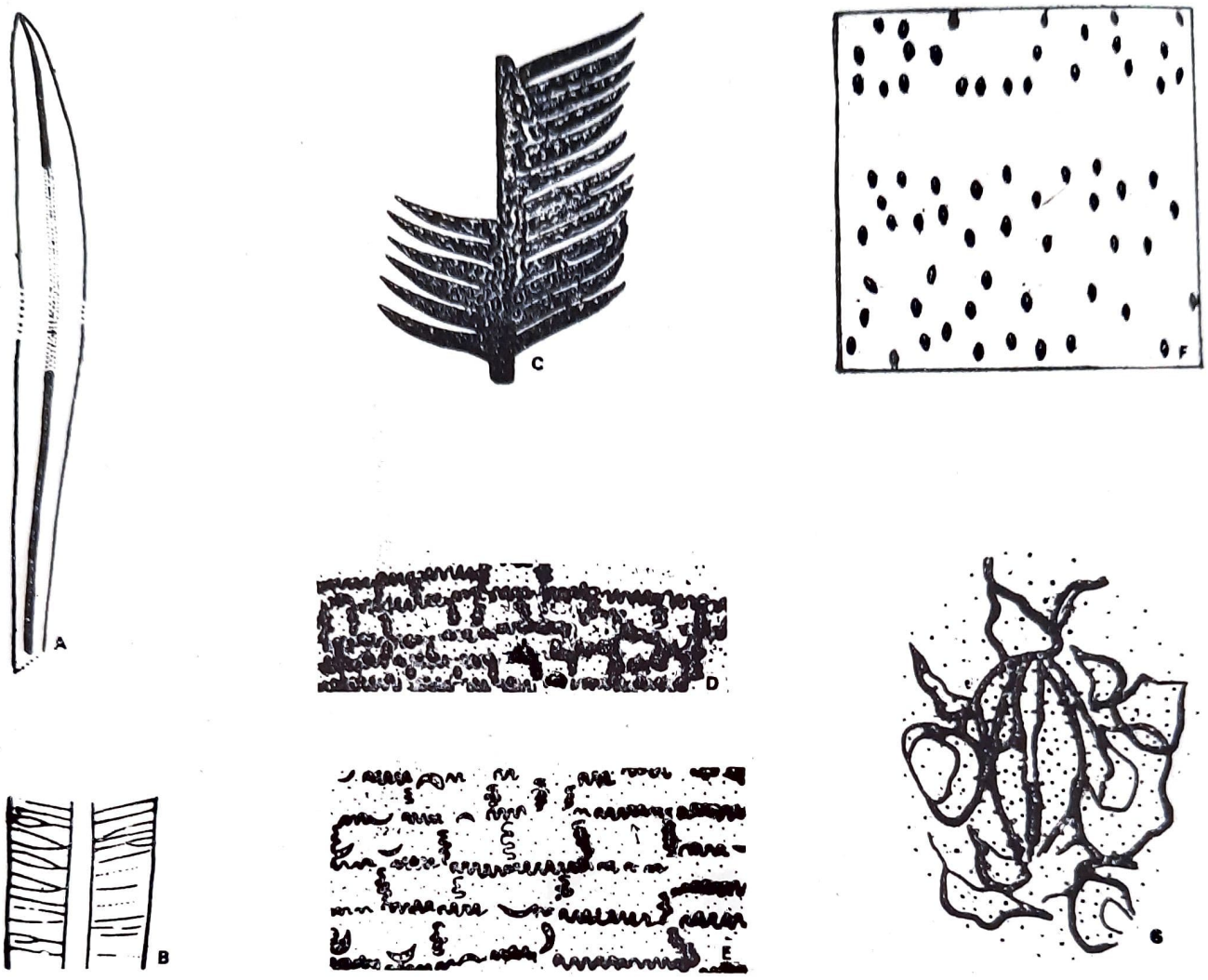
Remarks—The present specimens are mostly small. Only one specimen measures 9 × 1 cm which has an acute apex and incomplete base. These specimens in gross features and venation pattern closely resemble *Taeniopteris spatulata* McCl. described by Bose and Banerji (1981) from Rajmahal Hills, Bihar and Kutch, Maheshwari and Singh (1976) from Jaisalmer in India, Seward and Holttum (1922) from Sri Lanka and Chapman (1908) from Australia.

BENNETTITALES

Genus—*PTILOPHYLLUM* Morris 1840

Ptilophyllum acutifolium Morris
Pl. 4, fig. 3

Description—Leaves pinnate, lamina as a whole long, lanceolate, available length up to 9 cm, width 3.5 cm. Rachis partially concealed, 1-2 mm broad. Pinnae attached on upper surface of rachis by entire base at an angle of about 45°-70°, closely set, contiguous or slightly sparse, overlapping, narrow, linear, straight or slightly falcate,



Text-figure 2—**A, B,** *Taeniopteris spatulata* McCelland ; **A,** leaf, specimen no. B. S. I. P. 36185, ×1 ; **B,** portion of fig. A, magnified, venation, × 2; **C-G,** *Ptilophyllum horridum* Roy ; **C,** specimen no. B. S. I. P. 36191, × 1 ; **D,** upper cuticle slide no. B. S. I. P. 36215-I, X 150 ; **E,** lower cuticle, slide no. B. S. I. P. 36215-I × 150 ; **F,** lower cuticle showing distribution and orientation of stomata in 1 sq mm, slide no. B. S. I. P. 36215-I, ×40 ; **G,** lower cuticle showing stoma and papillae, slide no. B. S. I.P. 36215-I, × 500.

acroscopic basal edge rounded, basiscopic edge slightly decurrent, typically 0.3-1.5 cm long and 0.1-0.2 cm broad. Margin entire. Apex acute, sometimes apiculate. Veins arising from entire base, parallel, forked at places.

Collection—B. S. I. P. Museum. Specimen nos. 6/7210 and 36186.

Locality—Kondapalli, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—The present specimens are preserved as impressions. They mostly resemble in general morphological features with *P. acutifolium* Morris described by Bose and Banerji (1984). *P. acutifolium* here described has an apparent resemblance with the specimens of *P. acutifolium* described by Baksi (1968) from Raghavapuram. In possessing apiculate apex as well in some pinnae it resembles *P. jabalpurense* Jacob & Jacob described by Bose and Kasat (1972) and *Ptilophyllum* sp. cf. *P. jabalpurense* Jacob &

Jacob described by Mahabale and Satyanarayana (1979). Since the present specimens are preserved as impressions, further comparison is not yet possible.

Ptilophyllum cutchense Morris
Pl. 4, figs. 5, 6, 7, 8

1982 *Ptilophyllum cutchense* Morris : Bose, Kutty & Maheshwari, p. 125, pl. 1, fig. 4.

Description—Leaf pinnate, lamina linear, almost uniformly broad, available length 3.5-21.3 cm, breadth 0.6-2.6 cm. Rachis 1 mm wide, almost wholly concealed by pinnae bases. Pinnae small, alternate, typically 0.4-1.5 cm long and 0.1-0.2 cm broad, making an angle of about 60°-80° closely set, sometimes contiguous or slightly overlapping in the basal region by lower pinnae. Acroscopic basal edge slightly rounded, some slightly falcate, basiscopic edge straight or slightly decurrent. Apex obtuse or pointed. Veins arising from entire base, more less parallel, forked or unforked.

Collection—B. S. I. P. Museum Specimen nos. 5/2973C, 12/2709B, 36187, 36188 and 36189.

Locality—Ralapet and Nowgaon, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—The specimens described here resemble *Ptilophyllum cutchense* Morris emend. Bose and Kasat (1972). Bose, Kutty and Maheshwari (1982) have earlier described from Nowgaon *P. cutchense*, but their specimen is much smaller. The present specimens are larger and have distinct venation. In gross morphological features the present specimens resemble *P. cutchense* described by Bose and Banerji (1984, pl. 23, figs. 3, 5 ; pl. 24, figs. 1, 2), Feistmantel (1879, pl. 2, figs. 11-13, var. *minimum* pl. 9, figs. 7, 8) and Baksi (1968). They also resemble *P. institacallum* Bose described by Bose and Kasat (1972) in general appearance. However, the former lacks cuticular details, therefore further comparison is not yet possible.

Ptilophyllum distans (Feistmantel) Jacob & Jacob
Pl. 2, figs. 1-4 ; Pl. 3, fig. 2 ; Text-fig. 1 F-J

Description—Leaf pinnate, linear-lanceolate, 6 cm long and 1 cm wide. Rachis slender, about 1 mm wide, partially concealed by pinnae bases. Pinnae linear, oblong, alternate to subopposite, closely set, up to 4.5 mm long and 1-1.5 mm wide, attached on upper surface of rachis by entire base at an angle of about 75°-90°. Margin entire. Apex obtuse, rarely subacute. Upper basal margin slightly rounded, lower margin slightly decurrent, veins mostly indistinct.

Cells of upper surface of lamina rectangular, polygonal or squarish, anticlinal walls thick, sinuous, loops rounded. Stomata absent. Lower surface having stomata which tend to form indistinct bands due to frequent presence of stomata over vein regions. Stomata absent over margins. Marginal region about 5-10 cells wide. Cells mostly rectangular, narrow, some squarish or polygonal, arranged in rows, anticlinal walls thick, sinuous, loops deep. Periclinal walls unspecialized. Stomata transversely oriented, some slightly oblique. Subsidiary cells large, slightly more cutinised than ordinary epidermal cells, outer wall slightly wavy to sinuous, commonly having oval to circular solid papilla. Guard cells having crescent shaped thickening, inner wall towards opening slightly thickened, aperture oval to slit-like. Cells over veins squarish to rectangular, some polygonal, periclinal and anticlinal walls like other cells. Cells

amongst stomata squarish to polygonal, sometimes rectangular, anticlinal walls thick, sinuous, periclinal walls unspecialized. Ordinary cells on lower surface rarely having circular thickening or hair-bases.

Collection—B. S. I. P. Museum Specimen no. 36190.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—In general morphological features and cuticular details the specimen presently described comes close to *Ptilophyllum distans* (Feistmantel) Jocob & Jacob described by Bose and Kasat (1972) and Bose and Banerji (1984). Stomata in the present specimen tend to form ill defined bands. In *P. distans* the stomatal and non-stomatal bands are generally well defined but sometimes stomata occur on the vein regions as well.

Ptilophyllum horridum Roy

Pl. 1, fig. 6 ; Pl. 2, fig. 5, 6 ; Pl. 3, fig. 3, 4 ; Text-fig. 2 C-G

1963 *Ptilophyllum horridum* Roy, p. 396

1967 *Ptilophyllum horridum* Roy, p. 581, figs. 1, 2

1972 *Pitlophyllum horridum* Roy : Bose & Kasat, p. 125, pl. 4, figs. 30-38 ; Pl. 5, figs. 47-49, text-fig. 3A-G.

1984 *Ptilophyllum horridum* Roy : Bose & Banerji, p. 72, pl. 28, figs. 3-7, text-fig. 42A-G.

Emended Diagnosis (based on Bose & Kasat, 1972 and present material)—Leaf pinnate, exceeding 19.5 cm in length, uniformly broad, gradually tapering towards base and apex, width near middle 0.9-2 cm. Rachis concealed by pinnae, 1-2 mm wide. Pinnae closely set, almost touching each other, sometimes imbricate, mostly alternate, occasionally subopposite, arising at an angle of about 55°-70°. Pinnae 4-16 mm long, 1-3 mm wide near base, linear or linear-lanceolate, straight or slightly falcate. Apex apiculate, sometimes acute or obtuse. Acroscopic basal margin rounded, basiscopic basal margin decurrent. Veins faintly marked, forked or unforked, forking at different levels.

Rachis cells rectangular or squarish, rarely polygonal, anticlinal walls thick, wavy, sometimes sinuous with less prominent loops. Periclinal wall unspecialized. Hypodermis present.

Cells of lamina on upper surface rectangular, squarish, a few polygonal, more or less regular in arrangement, anticlinal wall sinuous, head of loops rounded, loops of end walls smaller than lateral walls, periclinal wall smooth or mottled. Lower cuticle differentiated into stomatiferous and non-stomatiferous bands. Stomatiferous bands broader than non-stomatiferous bands. Marginal non-stomatiferous bands without any hair or papilla, 5-12 cells wide, cells mostly rectangular or squarish, a few polygonal, generally serially arranged, anticlinal walls sinuous, loops prominent with rounded head. Other non-stomatiferous bands 3-5 cells wide ; cells rectangular, a few squarish or polygonal, arranged in regular rows, anticlinal walls sinuous, fairly thickwalled, surface mostly papillate, about 1-6 papillae present on a cell. Papillae variable in shape and size, rounded, crescent or mushroom shaped. Sometimes papipllae of some cells joining together and completely obscuring anticlinal walls. Sometimes cells non-papillate or having small thickening. Stomatiferous bands 2-6 stomata wide, mostly 3-4, rarely two stomata wide (near margin). Ordinary epidermal cells with 2-3 or more papillae, nature of papillae same as those of cells of nonstomatiferous bands, but, in the pre-

sent case papillae are more developed and irregularly lobed. In each cell, papillae fused together, forming a sort of ring over cell wall and completely obscuring it. Cells smaller in size than those of non-stomatiferous bands, rectangular or polygonal, anticlinal walls when visible sinuous, rarely wavy. Subsidiary cells papillate, slightly more cutinised than those of ordinary epidermal cells. Stomata in stomatal bands irregularly arranged, transversely oriented, a few slightly oblique. Stomatal apparatus covered by papillae of the same and adjacent cells. Guard cells sunken, having well developed crescent shaped thickenings.

Holotype—B. S. I. P. Museum Specimen no. 31889.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Comparison—In having apiculate apices of pinnae and papillae crowded over stomatal apparatus *P. horridum* resembles *P. indicum* Jacob and Jacob and *P. oldhamii* Jacob and Jacob described by Bose and Banerji (1984). In *P. oldhamii* the lower cuticle lacks well marked stomatal and non-stomatal bands which are present in *P. horridum*. In *P. indicum* subsidiary cells have solid circular raised papillae. Apices of pinnae in *P. jabalpurense* Jacob and Jacob described by Bose and Kasat (1972) are mostly apiculate and sometimes acute. Stomata are also arranged in stomatal and non-stomatal bands. However, in *P. jabalpurense* hair-bases are also present in addition to papillae on the vein bands and mostly a single circular hollow papilla is present on the cells of stomatal bands. *P. horridum* shows some resemblaces with *P. caucasicum* Doludenko and Svanidze (1969) in cuticular features. But in *P. horridum* the stomatal bands are broader than *P. caucasicum*. Moreover, both the species also differ in the nature of pinnae apices.

Ptilophyllum sp.
Pl. 4, figs. 1, 2, 4

Description—Leaf imparipinnate, lamina linear, gradually tapering towards apex, available length 0.8-4.2 cm , width 0.6-0.8 cm. Rachis about 1 mm wide, partially concealed by pinnae. Pinnae closely placed, separated or contiguous, small, straight or falcate, 0.3-0.7 cm long and 0.1-0.2 cm broad, degree of pinnation towards distal end of pinna gradually decreasing. Apex acute, some obtusely pointed. Acrosocpic basal edge slightly rounded, basiscopic edge joining straight to rachis.Margin entire. Venation obscure.

Collection—B. S. I. P. Museum Specimen nos. 36192, 36193, 36194, 22/2975 B and 63/2975 B.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

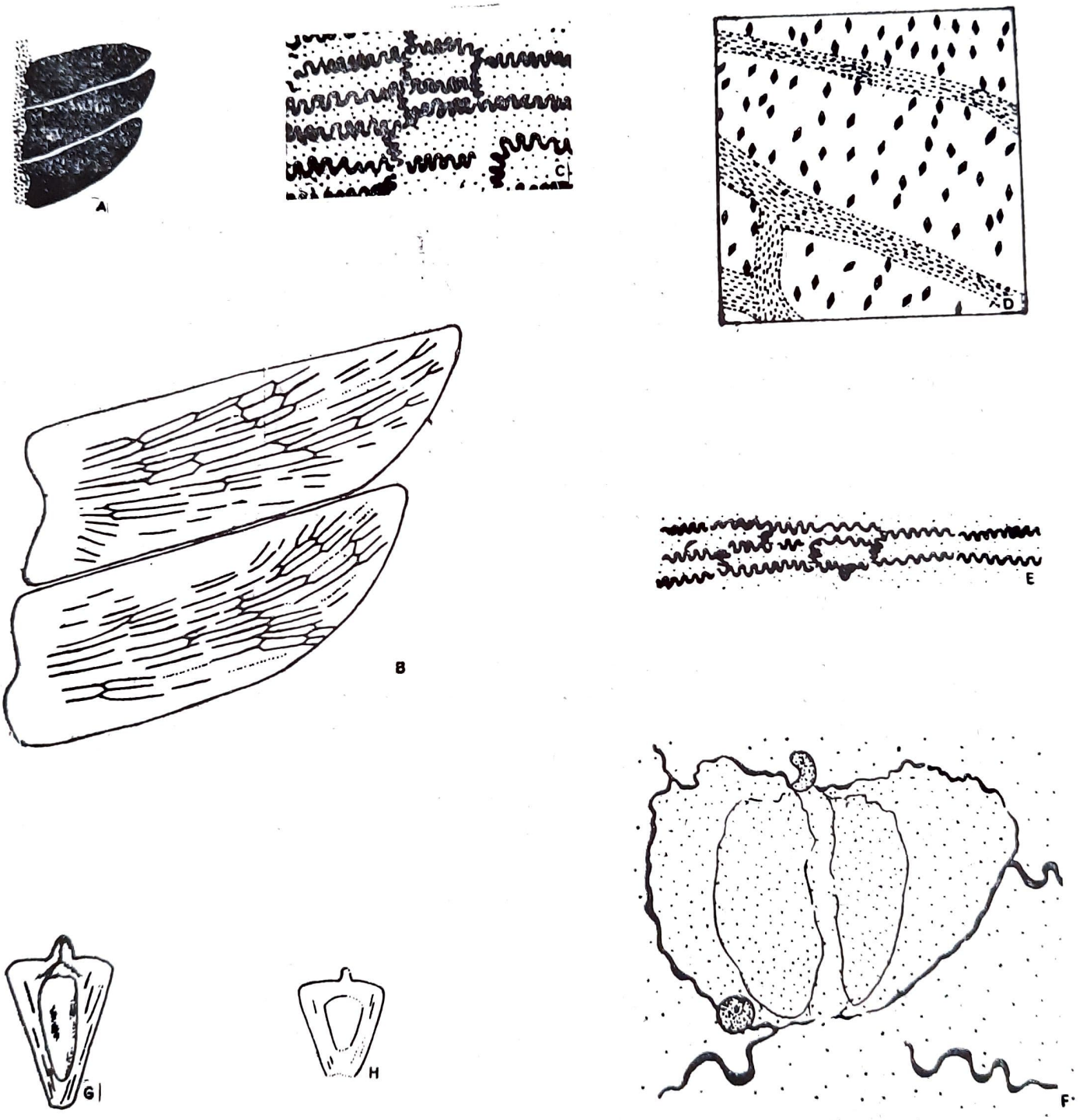
Comparison—*Ptilophyllum* sp. apparently resembles some of the figured specimens of *P. cutchense* (Pl. 2, fig. 17), *P. tenerrimum* (Pl. 2, fig. 18) and *P. indicum* (Pl. 3. fig. 2) described by Bose and Kasat (1972). However, in *Ptilophyllum* sp. the identity of pinnae is not distinct towards the apical portion of leaf.

Genus—*DICTYOZAMITES* Oldham 1863

Dictyozamites gondwanaensis n. sp.
Pl. 5, figs. 1-6 ; Text-fig. 3A-F

Diagnosis—Leaf pinnate, incomplete, up to 2.7 cm in length and 2.7 cm in breadth.

Rachis 1.5-2 mm wide, partially concealed by pinnae bases. Pinnae attached on upper surface of rachis at an angle of 70°-80°. alternate to subopposite, slightly sparse or contiguous, 17-20 mm long and 3-5 mm broad, straight or slightly falcate. Base auriculate. Apex subacute or obtuse. Margin entire. Veins arising from pinna base



Text-figure 3—**A-F**, *Dictyozamites gondwanaensis* n. sp ; **A,** holotype specimen no. B. S. I. P. 36195 A, ×1 ; **B** two pinnae from fig. A showing venation, ×3; **C,** lower cuticle, cells of interveinal region, slide no. B. S. I.P. 36195 B-1, × 150 ; **D,** lower cuticle showing distribution and orientation of stoma in 1 sq. mm, slide no. B. S. I. P. 36195 B-I, × 40 ; **E,** lower cuticle, cells over vein region, slide no. B. S. I. P. 36195 B-I, × 150 ; **F** a stoma and papillae, slide no. P. S. I. P. 36195 B-I, × 500 ; **G,** *Araucarites cutchense* Feistmantel, specimen no. B. S. I. P. 36209, ×2; **H,** *Araucarites minutus* Bose & Maheshwari, specimen no. B. S. I. P. 36210, ×2.

and forming meshes in the entire pinna. Meshes hexagonal to polygonal, elongate in the middle portion of pinnae, about 10-12 in number.

Cells on upper surface of cuticle variable in shape and size ; squarish, rectangular or polygonal, anticlinal walls sinuous, loops deep, prominent. Vein regions clearly marked by elongate, serially arranged cells with smaller loops. Stomata absent. Papillae and trichome-bases present here and there.

Lower surface vein regions distinct, 3-4 cells wide, cells mostly rectangular, arranged serially, anticlinal wall sinuous. Stomata present on lower surface on interveinal regions, numerous, distributed irregularly, transversely or obliquely placed. Subsidiary cells slightly more cutinised than ordinary epidermal cells, outer wall of subsidiary cells almost straight to sinuous. Guard cells having well-developed crescent shaped thickening, aperture elliptical or oval.

Papillae and trichome-bases quite common, distributed irregularly over lower surface.Subsidiary cells usually papillate, sometimes papillae overhanging guard cells. Ordinary epidermal cells in stomatiferous interveinal regions variable in shape and size, in the marginal regions longer than broad.

Holotype—B. S. I. P. Museum, Specimen no. 36195..

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Comparison—Amongst the Indian species of *Dictyozamites*, only *D. falcatus* (Morris) Medlicott & Blanford described by Bose and Zeba-Bano (1978) possesses cuticular structure. Rest of the species are in the form of impressions. ***D. gondwanaensis*** has only an apparent resemblance with *D. falcatus*. However, the latter species lacks papillae and trichome-bases, which is a characteristic feature of *D. gondwanaensis*. One of the present specimens (Pl. 5, fig. 1), resembles the smaller specimen of *D. feistmantelli* (Pl. 8, fig. 50) described by Bose and Zeba-Bano (1978). But cuticular details are not known in the latter species. *D. hawelli* Seward described by Harris (1969) from the Yorkshire has papillate leaves, but it lacks auriculate base of pinnae. Moreover, in *D. gondwanaensis* papillae are profusely developed unlike *D. hawelli*, *D. gondwanaensis* also apparently resembles *D. minusculus* described by Menendez (1966) from Argentina. Unlike *D. gondwanaensis* upper cuticle of leaf in *D. minusculus* lacks papillae and trichome-bases and each cell on lower cuticle is papillate.

CONIFERALES

Genus—*ELATOCLADUS* Halle 1913

Elatocladus confertus (Oldham & Morris) Halle
Pl. 9, figs. 1, 5 ; Pl. 9, fig. 1, 8 ; Pl. 10, fig. 4

1982 *Elatocladus confertus* (Oldham & Morris) Halle : Bose, Kutty & Maheshwri P. 127, pl. 1, figs. 7, 8, 13 ; pl. 2, fig. 15 ; text-fig. 2 M.

1982 *Elatocladus* sp. : Bose, Kutty & Maheshwari, p. 125, pl. 1, figs. 6, 11.

Description—Leaf twigs bearing branches irregularly at a distance of 0.5-1 cm and an angle of about 30°-60°. Leaves spirally borne, arranged more or less in two rows, lanceolate, straight or slightly bent backwards, close, 4-9 mm long, about 1 mm broad, making an angle of about 45°-80°. Margin entire. Apex acute, subacute or obtuse. Base contracted, sometimes twisted, decurrent. Midrib extending nearly to

apex. Leaves towards base and apex of a branch small and more or less scale-like. A few branches terminate in a poorly preserved female strobilus having some spirally borne loosely arranged megasporophylls bearing two rounded or oval seeds on their adaxial surface.

Collection—B. S. I. P. Museum Specimen nos. 36197, 9/2790B, 37196 and 36198.

Locality—Nowgaon and Ralapet,Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—Among the collected specimens of *Elatocladus confertus* one specimen shows a branched shoot bearing female strobilii terminally on the branches. Specimens of *Elatocladus confertus* described by Bose, Kutty and Maheshwari (1982) from the the Gangapur beds show close similarity with the present specimens, however, in the present specimens branching is clear and leaves are well preserved. In external features *E. confertus* described here resembles *E. confertus* described by Sahni (1928), Bose and Banerji (1984) from India and Halle (1913) from Graham Land. In general morphology the present specimens somewhat resemble *E. pseudotenerrima*, *E. sehoraensis* and *E. bosei* described by Maheshwari and Kumaran (1976) from Sehora, Narsinghpur district, M. P. and *E. chawadensis* described by Bose and Banerji (1984) from Kutch. In all these species cuticular structure of the leaves is known. The present specimens are preserved as impressions.Apart from these species , in the gross morphological characters *E. confertus* also matches somewhat with one of the specimens from Iran described by Corsin and Stampfli (1977).

Elatocladus sp. A

Pl. 8, figs. 2, 3, 4 ; Text-fig. 4 H-I

Description—Branched shoot, measuring 4 cm × 2.5 cm, branches making an angle of about 50°-60°. Leaves spirally borne, arranged in two rows, typically 5-8 mm long, 0.5-1.5 mm broad, more or less uniformly broad for a larger portion, base slightly constricted, making an angle of about 50°-70°. Margin entire. Apex acute, subacute or obtuse. Basiscopic margin decurrent. Midrib present.

Leaf hypostomatic. Upper surface slightly more cutinised than the lower, cells squarish, rectangular or polygonal, some arranged in short rows, lateral and end-wall thickened, straight, sometimes slightly curved, surface wall unspecialized. Lower surface having stomata avoiding midrib. Stomata scattered irregularly, ± circular or slightly elongate, distantly placed, longitudinally oriented, rarely obliquely placed, rarely adjacent stomata sharing common subsidiary cells. Subsidiary cells about 6-10, almost equally cutinised as ordinary epidermal cells, guard cells thinly cutinised. Ordinary epidermal cells polygonal, some squarish or rectangular, irregular, lateral and end-walls thickened, straight, sometimes slightly curved, surface wall unspecialized, devoid of papillae.

Collection—B. S. I. P. Museum Specimen no. 36200.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Comparison—The present specimen resembles in most of the external and cuticular features with *Elatocladus chawadensis* Bose & Banerji (1984) described from Kutch. In both leaves are hypostomatic and subsidiary cells are almost equally cutinised as other epidermal cells. However, in the present specimen the stomata and subsidiary cells are more in number. *E. kingianus* Bose, Kutty & Maheshwar (1982) described from the

Gangapur Formation is also hypostomatic,, but unlike the present specimen, stomata are arranged in a band along the midrib and subsidiarry cells are less in number. In *E. sahnii* Vishnu-Mittre (1959) known from Nipania the stomata are scattered on lower surface. However, *E. sahnii* is distinguished by its smaller leaves having less numbe. of subsidiary cells. In the case of *E. bosei* and *E. sehoraensis* described by Maheshwari and Kumaran (1976) leaves are amphistomatic. In *E. pseudotenerrima* described by Maheshwari and Kumaran (1976) the leaves are hypostomatic, but stomata are arranged in bands unlike the present species. Due to lack of sufficient well preserved material the present specimen is described here as *Elatocladus* sp.

Elatocladus sp. B
Pl. 10, figs. 1, 2

Description—Sterile leafy shoot, available length 2.5 cm, breadth 2.3 cm. Stem slender, 1 mm wide. Leaves spirally borne, attached by whole base at an angle of 35°-50°, elongated, gradually tapering towards apex, nearly acicular, 1.7 cm long and 0.1 cm broad. Leaf-base twisted, slightly contracted. Margin entire, Apex tapering, slightly bending downwards. Midrib prominent, 0.5 mm wide, traversing entire length.

Collection—B. S. I. P. Museum, Specimen no. 36201.

Locality—Ralapet, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

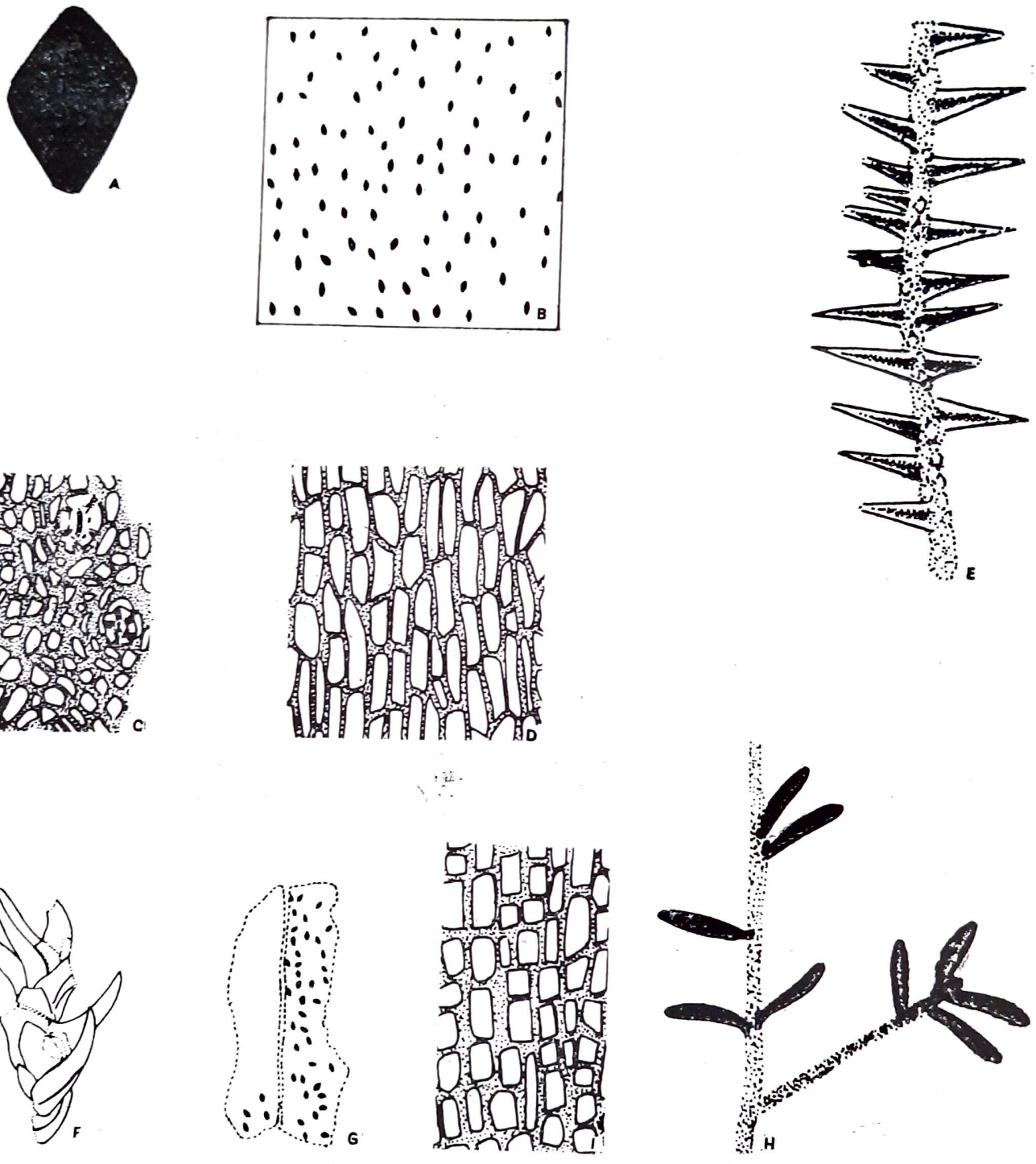
Comparison—The present specimen is characterised by its spiny elongated leaves with pointed tips which are sometimes curved. To some extent *Elatocladus* sp. comes nearer to *E. plana* described by Sahni (1928) and Sitholey (1944). In possessing elongated leaves *Elatocladus* sp. also resembles *E. longifolium* described by Borkar and Chiplonkar (1973) from the Umias of Saurashtra, Gujarat. However, the latter species shows dimorphism of leaves and lacks twisting of the base as seen here in *Elatocladus* sp.

Genus—*PAGIOPHYLLUM* Heer 1881

Pagiophyllum marwarensis Bose & Sukh-Dev
Pl. 6, figs. 2, 3, 6, 7, 8 ; Text fig. 4 FG,

Description—Leafy twig, measuring 1.7 ×0.8 cm, unbranched. Leaves 4.5 ×1.5-1.8 mm in size, traingular, elongate, straight or falcate, close, spirally borne, directed forward or towards sides, arising from a rhomboidal leaf-base cushion. Margin entire, apex acute.

Cuticle on both surfaces of almost equal in thickness, about 6-7 μm thick (in folds), amphistomatic. On upper surface stomata arranged in two stomatal bands which converge towards apex. Stomata in stomatal band arranged in short irregular files, mostly transversely oriented, some obliquely or rarely longitudinally placed. Subsidiary cells mostly five in number, slightly more cutinised than oridnary epidermal cells. Guard cells sunken, aperture slit-like. Encircling cells sometines present, slightly more cutinised. Ordinary cells on both surfaces squarish, rectangular or polygonal, sometimes, slightly curved, anticlinal walls straight, 4-5 μm thick. On lower surface stomata less in number, mostly confined to basal portion of leaf. Hypodermis present under both surfaces.



Text-figure 4—**A-D**, *Brachyphyllum sehoraensis* Bose & Maheshwari ; **A,** leaf, specimen no. B. S. I. P. 36206, × 2; **B,** lower cuticle showing distribution and orientation of stomata in 1 sq mm, slide no. B. S. I. P. 36206-I, × 40 ; **C,** lower cuticle showing two stomata, slide no. B. S. I. P. 36206-I, × 150 ; **D,** upper cuticle, slide no. B. S. I. P. 36206-II, × 150 ; **E,** *Pagiophyllum spinosum* n. sp. holotype, specimen no. B. S. I. P. 36203 × 1 ; **F, G,** *Pagiophyllum marwarensis* Bose & Sukh-Dev ; **F,** specimen no. B. S. I. P. 36202, × 2; **G,** cuticle showing distribution and orier tation of stomata on lower (left) and upper (right) surfaces of leaf, slide no. B. S. I. P. 36202 I, ×40. **H-I**, *Elatocladus* sp. A; **H**, leafy branched twig showing few leaves, specimen no. 36200, ×2; **I,** upper cuticle, slide no. B. S. I. P. 36200-I, × 150.

Collection—B. S. I. P. Museum. Specimen no. 36202.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—In gross morphological features and cuticular details the present specimen is similar to *P. marwarensis* Bose & Sukh-Dev (1972). However, no sclereids and radiating canals have been observed on the epidermis of the leaves in the present specimen as mentioned by Srivastava, Nautiyal and Pant (1984) in their specimens of *P. marwarensis*. Bose, Kutty and Maheshwari (1982) also described *P. marwarensis* from Gangapur Formation but from other localities.

Pagiophyllum spinosum n. sp.
Pl. 6, fig. 4 ; Text-fig. 4E

Diagnosis—Leafy branched shoot, available length 7 cm, breadth 2.8 cm. Branches arising at an angle of 65°-70°. Leaves spirally borne, triangular, elongate, broad at base and narrowing rather abruptly to an acute apex, spinous, stiff, 2-6 mm long and 0.5-1 mm broad, directed sideways at an angle of 60°-85°. Margin entire. Leafbase cushion ±rhomboidal. Leaves short-triangular at the basal portion of branches.

Holotype—B. S. I. P. Museum Specimen no. 36203.

Locality—Ralapet, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretacous.

Comparison—Pagiophyllum spinosum is characterised by its spiny leaves which are dimorphic. *P. spinosum* somewhat resembles *Pagiophyllum* cf. *P. divaricatum* (Bunbury) and *P. burmense* described by Sahni (1928) in the spinuous habit. However, in *Pagiophyllum spinosum* leaves are larger, more spreading and straight as compared to them. Straight and pointed leaves somewhat resembling *P. spinosum* are also present in *P. rewaensis* described by Bose and Sukh-Dev (1972) and *P. marwarensis* described by Bose and Sukh-Dev (1972) and Srivastava, Nautiyal and Pant (1984) from Bansa, Madhya Pradesh. In both the species leaves are generally falcate and lack short triangular leaves at the base of branches which is a characteristic feature in *P. spinosum*. Leaves in *Pagiophyllum* cf. *crassifolium* (Schenk) described by Halle (1913) from the Graham Land, like *P. spinosum*, are sparse and of same size. However, the former species is quite distinct in having falcate leaves which are all alike.

Pagiophyllum sp.
Pl. 6, figs. 1, 4

Description—Fragmentary leafy shoot, unbranched, 2.5 × 1.5 cm in size. Leaves spirally borne at a wide angle of about 45°-80°, close, lanceolate, slightly falcate, 2-3 mm long and 0.8-1 mm broad, attachment area ±rhomboidal, leaf-base decurrent. Margin entire. Apex acute.

Collection—B. S. I. P. Museum Specimen no. 36204.

Locality—Ralapet, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Comparison—Pagiophyllum sp. has apparent resemblance with *Pagiophyllum bansaensis* Bose & Sukh-Dev (1972). In both leaves are small, lanceolate, falcate and directed forward. In general shape and size of leaves *Pagiophyllum* sp. comes close to *Pagiophyllum sherensis* and *P. satpuraensis* described by Maheshwari and Kumaran (1976) from Sehora, Narsinghpur District, Madhya Pradesh. *Pagiophyllum* sp. also apparently resem-

bles *P. rotzoanum* (Massalongo) Wesley (1956) known from Jurassic of Italy. But due to lack of cuticular details in *Pagiophyllum* sp. further comparison is not possible.

Genus—*BRACHYPHYLLUM* Brongniart 1828

Brachyphyllum schoraensis Bose & Maheshwari
Pl. 7, figs. 1-7 ; Text-fig. 4A-D

Description—Isolated leaves, 9-12 mm long and 7-9 mm broad, rhomboidal. Margin entire. Apex rounded. Leaves hypostomatic. Upper cuticle about 2.5-3 μm thick (in folds), cells mostly longer than broad, rectangular or polygonal. Anticlinal walls 6-8 μm thick, straight or slightly curved. Periclinal wall unspecialized. Stomata absent. Cuticle of lower surface 6-8 μm thick (in folds). Cells variable in shape and size, rectangular, squarish or polygonal. Anticlinal walls 6-10 μm thick. Periclinal wall smooth, occasionally thin slits present. Stomata numerous, mono or dicyclic, irregularly distributed and oriented over entire surface, less towards base. Subsidiary cells 6-9, mostly 7 or 8, slightly more cutinised than ordinary epidermal cells. Guard cells deeply sunken, thinly cutinised.

Collection—B. S. I. P. Museum Specimen nos. 36205 and 36206.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—Only two isolated leaves were found which match in their shape, size, stomatal structure and distribution with *Brachyphyllum sehoraensis* Bose & Maheshwari (1973a) described from Sehora, Narsinghpur District, Madhya Pradesh.

Genus—*ALLOCLADUS* Townrow 1967

Allocladus bansaensis Sukh-Dev & Zeba-Bano

Description—Branched leafy twigs, up to 1.5-2 cm wide, straight or slightly curved, branches arising at an angle of about 20°-60°. Leaves small, spirally borne, appressed, rhomboidal, mostly longer than broad, sometimes almost as long as broad, 1-2 mm in size, contiguous or overlapping. Leaves arising from ± rhomobidal leaf-base cushion. Margin entire. Apex acute or obtuse.

Collection—B. S. I. P. Museum, Specimen nos. 1/2709A, 23/2709, 36207 and 36208

Locality—Nowgaon and Kondapalli, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—The leaves in the present specimens are rhomboidal and appressed on the stem as in *Allocladus bansaensis* Sukh-Dev & Zeba-Bano known from Jabalpur Formation (Sukh-Dev & Zeba-Bano, 1979; Srivastava, Nautiyal & Pant, 1984). Since the leaves in *A. banasensis* have a characteristic shape, size and attachment the present specimens are therefore identified as *A. bansaensis* though they lack cuticular structure.

Genus—*ARAUCARITES* Presl 1838

Araucarites cutchensis Feistmantel

Description—Detached seed-scales, length 2.1-2.4 cm and width 1.4-1.8 cm, wedge-shaped broader towards distal and with rounded shoulders, sides slopping to a truncate base, tip up to 4 mm long and 5 mm broad, striated. Ligule absent.

Collection—B. S. I. P. Museum. Specimen nos. 30/2975B and 36209.

Locality—Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—The present specimens are preserved as impressions. They closely resemble *Araucarites cutchensis* described by Bose and Maheshwari (1973b), Bose and Banerji (1984), Sukh-Dev and Zeba-Bano (1981) and Sitholey (1973) described from various Jurassic-Lower Cretaceous beds in India.

Araucarites minutus Bose & Maheshwari
Pl. 9, figs. 2, 4 ; Text-fig. 3 H

Description—Detached seed-scales, about 1-1.4 cm long and 0.7-1.1 cm in width, obcuneate, shoulders slightly raised, sides narrowing to a truncate base, tip short, about 1-2 mm long. Seed possibly immersed, obovate, about 7 × 3 mm in size. Ligule absent.

Collection—B. S. I. P. Museum Specimen nos. 36210, 36211 and 67/2975B.

Locality—Nowgaon and Butarmal Nala, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—In shape and size of seed scales the specimens from Gangapur Formation closely match with *A. minutus* described by Bose and Maheshwari (1973b) from Sehora, Narsinghpur District, Madhya Pradesh. The specimens of the same species described from Kutch by Bose and Banerji (1984) also resemble in external features.

Genus—*CONIFEROCAULON* Fliche 1900

Coniferocaulon rajmahalense Gupta 1982

1982 *Coniferocaulon* sp. *C. rajmahalense* Gupta ; Bose, Kutty & Maheshwari, p. 128, text figs. 30.

Description—Stems incomplete, 15 cm long and 13 cm wide, marked with transversely extended discontinuous irregular grooves and ridges. Grooves and ridges close or distantly placed. At places circular to elliptical protuberances present.

Collection—B. S. I. P. Museum Specimen nos. 36212 and 36213.

Locality—Nowgaon and Ralapet, Adilabad District, Andhra Pradesh.

Horizon & Age—Gangapur Formation, Early Cretaceous.

Remarks—The present specimens closely resemble the specimens of *C. rajmahalense* described by Gupta (1984) from Rajmahal Hills, Bose (1957) from Sehora and Bose, Kumaran and Banerji (1982) from Habur. The ridges and grooves in the present specimens are closer as well as distantly placed. The small specimens described by Bose, Kutty and Maheshwari (1982) from Gangapur Formation as *Coniferocaulon* cf. *C. rajamahalense* Gupta probably belong to *C. rajmahalense*.

Discussion

The fossil flora of the Gangapur Formation systematically described here (also incorporating earlier reports) consists of 23 genera and 45 species (see Table 1). This assemblage is dominated by conifers followed by cycadophytes and pteridophytes respectively. Pteridosperms are very rare. Ginkgoales and Pentoxyleae are not yet been recorded. In the present study the following species have been described for the first time :

Pachypteris gangapurensis n. sp.

Table 1—Distribution of plant fossils in the Gangapur Formation

	Nowgaon	Kondapalli	Rala-pet	Katta-rala	Butar-mal Nala	Moar	Chira kunta	Ank-sapur	Gang-apur
Equisetites sp.	—	—	+	+	—	—	—	+	—
? *Cladophlebis* sp.	—	—	—	—	—	—	—	+	—
Cladophlebis sp.	+	—	+	+	—	—	—	—	—
C. indica	—	—	+	+	—	—	—	—	—
Gleichenia nordenskioldii	+	—	—	—	—	—	—	—	—
G. rewahensis	—	—	+	+	—	—	—	—	—
G. gleichenoides	—	—	+	+	—	—	—	—	—
G. sp.	—	—	+	+	—	—	—	—	—
Hausmannia sp.	—	—	—	+	—	—	—	—	—
Pachypteris gangapurensis	—	—	—	—	+	—	—	—	—
Taeniopteris sp. cf. *T. spatulata*	+	—	—	—	—	—	—	—	—
T. spatulata	—	—	+	+	+	—	—	—	—
Cycadites sp.	—	—	—	—	—	—	+	—	—
Cycadolepis sp.	—	—	—	—	—	—	+	—	—
Nilssonia sp.	—	—	+	+	—	—	—	—	—
? *Anomozamites* sp.	+	—	—	—	—	—	—	—	—
Otozamites sp.	—	—	+	—	—	—	—	—	—
Pterophyllum medlicottianum	—	—	+	—	—	—	—	—	—
Otozamites sp.	—	—	+	+	—	—	—	—	+
Ptilophyllum sp.	—	—	+	+	+	—	—	—	—
P. sp. cf *acutifolium*	+	—	—	—	—	—	—	—	—
P. acutifolium	—	+	+	—	—	—	—	+	—
P. cutchense	+	—	+	—	—	—	—	—	—
P. distans	—	—	—	—	+	—	—	—	—
P. horridum	—	—	—	—	+	—	—	—	—
Dictyozamites gondwanaensis	—	—	—	—	+	—	—	—	—
Elatocladus sp. A	—	—	—	—	+	—	—	—	—
Elatocladus sp. B	—	—	+	—	—	—	—	—	—
Elatocladus sp.	+	—	—	—	+	—	—	—	—
E. confertus	+	—	+	+	+	—	+	—	+
E. jabalpurensis	+	—	—	+	—	—	—	+	—
E. kingianus	—	—	+	+	—	—	—	—	+
E. plana	—	—	+	+	—	—	—	—	—
Pagiophyllum sp.	—	—	+	—	—	—	—	—	—
P. spinosum	—	—	+	—	—	—	—	—	—
P. marwarensis	+	—	—	—	+	+	+	—	—
P. peregrinum	—	—	+	—	—	—	—	—	—
P. burmense	—	—	+	+	—	—	—	—	—
Brachyphyllum sp.	—	—	—	—	+	—	—	—	—
B. sehoraensis	—	—	—	—	+	—	—	—	—
Allocladus bensaensis	+	—	+	—	—	—	—	—	—
Araucarites sp.	—	—	+	+	—	—	—	—	—
A. cutchensis	+	+	—	—	+	—	—	—	—
A. minutus	+	—	—	—	+	—	—	—	—
Athrotaxites feistmanteli	+	—	—	—	—	—	—	—	—
Conferocaulon sp. cf. *C. rajmahalense*	+	—	—	—	—	—	—	—	—
C. rajmahalense	+	—	—	—	—	—	—	—	—
Torreytites	—	—	—	+	—	—	—	—	—

Dictyozamites gondwanaensis n. sp.
Ptilophyllum distans (Feistmantel) Jacob & Jacob
Ptilophyllum horridum Roy
Elatocladus sp. A
Elatocladus sp. B
Pagiophyllum spinosum n. sp.
Brachyphyllum sehoraensis Bose & Maheshwari
Allocladus bansaensis Sukh-Dev & Zeba-Bano
Araucarites minutus Bose & Maheshwari
Coniferocaulon rajmahalense Gupta

On the whole the pteriodyphytes are represented by the families Equisetaceae (*Equisetites*), Cyatheaceae (*Coniopteris*), Gleicheniaceae (*Gleichenia*), Dipteridaceae (*Hausmannia*) and unclassified fern (*Cladophlebis*). Pteridosperms are represented by a single family Corystospermaceae (*Pachypteris*). Cycadophytes consists of *Taeniopteris*, ? *Nilssonia*, *Pterophyllum*, *Otozamites*, *Dictyozamites Ptilophyllum*, *Cycadites* and *Cycadolepis*.

Elatocladus is the dominant form in the beds of Kondapalli and Nowgaon and is associated with *Pagiophyllum*, *Araucarites*, *Allocladus*, *Coniferocaulon*, *Ptilophyllum*, *Taeniopteris* and *Cladophlebis*. The bed from where incrustations were recovered (Butarmal Nala) was dominated by the genus *Ptilophyllum*, associated with *Taeniopteris*, *Dictyozamites*, *Pachypteris*, *Pagiophyllum Brachyphyllum*, *Araucarites* and *Elatocladus*.

The Gangapur beds are closer to the Sehora beds of Jabalpur Formation in the abundance of conifers and nature of *Ptilophyllum* leaves. The common species are *Ptilophyllum distans* (Feistmantel) Jacob & Jacob. *Ptilophyllum horridum* Roy, *Pagiophyllum, marwarensis* Bose and Sukh-Dev, *Brachyphyllum sehoraensis* Bose & Maheshwari, *Allocladus bansaensis* Sukh-Dev & Zeba-Bano, *Elatocladus jabalpurensis* (Feistmantel) Sahni, *Araucarites minutus* Bose & Maheshwari and *Araucarites cutchense* Feistmentel. But following forms are found in Sehora, which are not yet been known from Gangapur beds :

Onychiopsis psilotoides (Stokes & Webb)
Ptilophyllum jabalpurense Jacob & Jacob
Ptilophyllum institacallum Bose
Allocladus sehoraensis Sukh-Dev & Zeba-Bano
Pagiophyllum satpurensis Maheshwari & Kumaran
Pagiophyllum sherensis Maheshwari & Kumaran

The following forms are present in Gangapur beds but not yet known from Sehora beds :

Pachypteris gangapurensis n. sp.
Dictyozamites gondwanaensis n. sp.
Pagiophyllum spinosum n. sp.
Elatocladus kingianus Bose, Kutty & Maheshwrari

The Gangapur and Bansa (Lower Cretaceous) beds have *Gleichenia rewahensis* Feistmantel, *Gleichenia nordenskioldii* Heer, *Pagiophyllum marwarensis* Bose & Sukh-Dev and *Allocladus bansaensis* Sukh-Dev & Zeba-Bano in common. In the Bansa beds *Ptilophyllum* is rare and *Dictyozamites* is not known. Moreover, Bansa floral assemblage is quite district in having *Weichselia*, *Onychiopsis*, *Cycadopteris*, *Yabiella*, *Marwaria* and a number of other distinct floral elements.

The fossil flora of Gangapur Formation to some extent resembles the flora at some localities of Bhuj Formation, e.g., Trambau, Sukhpur, in having common genera

Ptilophyllum, *Brachyphyllum*, *Allocladus* and *Pagiophyllum*. In other localities, e.g., Kurbi Kakadbhit, etc. of Bhuj Formation, *Linguifolium*, *Sagenopteris*, *Nilssoniopteris*, *Pterophyllum* and *Otozamites* are present and are very rare or not yet known from Gangapur beds. Bose and Banerji (1984) consider the latter assemblage found in Bhuj Formation as Middle Jurassic and the former as Upper Jurassic with which Gangapur floral assemblage shows some resemblance.

The fossil assemblage of Pariwar Formation, Jaisalmer Basin comprises of ? *Gleichenites* sp., *Phlebopteris* sp., *Pachypteris haburensis*, *Taeniopteris spatulata*, *T. vittata*, *T. densinervis*, *Ptilophyllum acutifolium*, *Ginkgo* sp., *Elatocladus tenerrimus*, *Elatocladus confertus*, *Pagiophyllum* sp., *Araucarites* sp. cf. *A. cutchense* and *Coniferocaulon rajmahalense* and this flora is considered to be ? Upper Jursassic-Lower Cretaceous in age. The floral assemblage of Gangapur Formation is distinct from the Pariwar floral assemblage in lacking *Phlebopteris*, *Pterophyllum*, *Otozamites* and *Ginkgo*.

The younger Mesozoic Gondwana beds such as Himmatnagar, Kathiawar and Gardeshwar in the Western India are characterized by the absence of bennettitalean fossil remains. The forms such as *Matonidium* and *Weichselia* are found in Himmatnagar and Kathiawar, the latter not yet known from Gardeshwar. Gangapur floral assemblage is distinct from them in having well represented bennettitalean remains and in lacking *Matonidium* and *Weichselia*.

The floras found in the East coast Mesozoic Gondwana equivalent outcrops lack the forms found in the Gangapur beds such as *Pachypteris gangapurensis*, *Ptilophyllum distans*, *P. horridum*, *Pagiophyllum spinosum* and *Allocladus bansaensis*. Moreover, the genus *Dictyozamites* is rare in Gangapur beds, while it is quite commonly found in Vemavaram, Gollapalli, Raghavapuram, Sriperumbudur and Sivaganga beds.

The Rajmahal floral assemblage is characterized by the abundance of cycadophytes and is considered to be of Upper Jurassic in age. At Nipania conifers dominate the floral assemblage and is younger in age. Interestingly radiometric studies indicate a Lower Cretaceous (Aptian) age to the Lower Rajmahal traps (Agarwal & Rama, 1976). However, Gangapur floral assemblage is younger than the flora found in the Rajmahal Hills (excluding Nipania). This discrepancy in age correlation raise the question as how to fit plant fossil evidences ?

Palynofossil studies mostly advocate a Lower Cretaceous age to the Gangapur beds (Ramanujam & Rajeshwar Rao, 1979, 1980, Bose *et al.* 1982, Rajeshwar Rao *et al.*, 1983). The characterstic forms of Lower Cretaceous comprises of *Cooksonites*, *Coptospora*, *Aequitriradites*, *Crybelosporites*, *Ornamentifera*, *Contingnisporites*, *Cicatricosisporites*, *Impardecispora* and *Microcachryidites*. This assemblage is more akin to *Microcachryidites antarcticus* zone of Neocomian age as assigned by Venkatachala *et al.*, 1972 (Bose *et al.*, 1982). Megafloristically the Gangapur beds are close to Sehora beds, Jabalpur Formation. Palynological studies of the Sehora beds were carried out by Sukh-Dev (1961), Singh (1966) and Kumar (1973). On one hand Bharadwaj, Kumar and Singh (1972) consider the Jabalpur floral assemblage (Sehora), to be of Upper Jurassic in age, while on the other Singh (1966, 1974) suggests an Early Cretaceous age. The Gangapur palynoassemblage has the dominance of *Microcachryidites* followed by *Callialasporites* and *Araucariacites* (Rajeshwar Rao *et al.*, 1983), while the Jabalpur microflora (Sehora) has the dominance of *Araucariacites* followed by *Cycadopites* and *Callialasporites* (Bharadwaj *et al.*, 1972). Hence, differences in both micro-and mega-flora of Gangapur and Sehora sediments exist.

The Gangapur palynoasemblage also shows a striking palynological similarity with the Bhuj assemblage (Rajeshwar Rao *et al.*, 1983). The Bhuj assemblage (zone 3) has been considered as Lower Cretaceous on palynological evidences (Venkatachala & Kar, 1970). However, megafloral studies of Bhuj Formation advocate Middle-Upper Jurassic age (Bose & Banerji, 1984).

The stratigraphic position of Gangapur beds is in between the underlying Kota sediments having ? Middle Jurassic or slightly younger flora and overlying Chikiala/ Trap flows. The interrelationship of Gangapur and Chikiala beds is not definitely known. Rudra (1972) suggested that Chikiala beds overlies the Gangapur sediments. Rao and Shah (1960b) reported *Cladophlebis indica*, *Hausmannia* cf. *buchii*, *Hausmannia* sp., *Thinnfeldia odontopteroides*, *Ptilophyllum acutifolium*, *Taeniopteris spatulata*, *Otozamites* sp., *Dictyozamites* sp., *Nilssonia* sp. and *Araucarites* sp. from the Chikiala beds and suggested "Chikiala beds are most probably equivalent to Jabalpur beds". King (1881) related Chikiala beds with Tirupati Sandstone of Krishna-Godavari Basin. The underlying Kota sediments yielded conifer fossil woods and the overlying ? equivalent Chikiala beds with the Gangapur beds yielded fragmentary plant fossils so far. Stratigraphically the Gangapur beds are younger than the flora of Kota (?Middle Jurassic). Further studies may help to know the inter-relationship between Gangapur and Chikiala beds as the plant fossils of the latter as reported by Rao and Shah (1960b) appears to be older than the flora of Gangapur as evidenced by the present study.

As authentic faunal evidences are not known from Gangapur beds the above discussed micro-and mega-floral evidences and the stratigraphic position of Gangapur Formation is suggestive of an Early Lower Cretaceous age.

The overall floral composition indicates preponderance of gymnosperms, in which the conifer elements dominate the flora. There was a considerable variation in the stomatal structure, distribution and nature and distribution of papillae which indicate changes in the microenvironment and evolutionary variations. It appears that there was an upland vegetation consisting of conifer trees with the undertier comprising of cycadophytic vegetation. The pteridophytes probably represented the local low land vegetation and the overall climate as indicated by micro-and mega-flora might be sub-tropical.

References

Agarwal, J. K & Rama. (1979). Chronology of Mesozoic Volcanics of India. *Proc. Indian Acad. Sci.*, **84A** (4) : 157-179.

Baksi, S. K. (1968). Fosssil plants from Raghavapuram Mudstone, West-Godavari District, A. P. *Palaeobotanist*, **16**(3) : 206-215.

Bharadwaj, D. C., Kumar, P. & Singh, H. P. (1972). Palynostratigraphy of coal deposits in Jabalpur Stage, Upper Gondwana, India. *Palaeobotanist*, **19**(3) : 225-247.

Borkar, V. D. & Chiplonkar, G. W. (1973). New Plant fossils from the Umias of Saurashtra. *Palaeobotanist*, **20**(3) : 269-279.

Bose, M. N. (1957). Some fragmentary plant fossils from Narsinghpur District, Madhya Pradesh, India. *Palaeobotanist*, **6** : 49-50.

Bose, M. N. (1958). The fossil flora of the Jabalpur Series-2. Filicales. *Palaeobotanist*, **7**(2) : 90-92.

Bose, M. N. & Banerji, J. (1981). Cycadophytic leaves from Jurassic-Lower Cretaceous rocks of India. *Palaeobotanist*, **28-29** : 218-300.

Bose, M. N. & Banerji, J. (1984). The fossil floras of Kachchh-I, Mesozoic megafossils. *Palaeobotanist*, **33** : 1-189.

Bose, M. N. & Kasat, M. L. (1972). The genus *Ptilophyllum* in India. *Palaeobotanist*, **19**(2) : 115-145.

Bose, M. N. Kumaran, K. P. N. & Banerji, J. (1982). *Pachypteris haburensis* n. sp. and other plant fossils from the Pariwar Formation. *Palaeobotanist*, **30**(1) : 1-11.

Bose, M. N., Kutty, T. S. & Maheshwari, H. K. (1982). Plant fossils from the Gangapur Formation. *Palaeobotanist* **30**(2) : 121-142.

Bose, M. N. & Maheshwari, H. K. (1973a). *Brachyphyllum sehoraensis* a new conifer from Schora, Narsinghpur District, Madhya Pradesh. *Geophytology*, **3**(2) : 121-125.

Bose, M. N. & Maheshwari, H. K. (1973b). Some detached seedscales belonging to Araucariaceae from the Mesozoic rocks of India. *Geophytology*, **3**(2) : 205-214.

Bose, M. N. & Maheshwari, H. K. (1974). Mesozoic Conifers. *In :* Surange *et al.* (eds)—*Aspects and Appraisal of Indian Palaeobotany*, Birbal Sahni Institute of Palaeobotany, Lucknow : 212-223.

Bose, M. N. & Roy, S. K. (1968). On the occurrence of *Pachypteris* in the Jabalpur Series of India. *Palaeobotanist*, **16**(1) : 1-9.

Bose, M. N. & Sah, S. C. D. (1968). Some pteridophytic remains from the Rajmahal Hills, Bihar. *Palaeobotanist*, **16**(1) : 12-28.

Bose, M. N. & Sukh-Dev (1972). Three new species of *Pagiophyllum* from Bansa, Madhya Pradesh, India. *Geophytology*, **1**(2) : 116-122.

Bose, M. N. & Zeba-Bano (1978). The genus *Dictyozamites* Oldham from India. *Palaeobotanist*, **25** : 79-99.

Brongniart, A. (1828). Prodrome d'une histoire des vegetaux fossiles. *Dietionusire Sci. Nat.*, **57** : 61-212.

Brongniart, A. (1832). Histoire des Vegetaux fossiles. On recherches botaniques et geologiques sur les vegetaux renfermes dens les diver couches du globe, **1**, (1828-1837), Paris.

Brongniart, A (1849). Tableu des genres de Vegetaux fossiles consideres sous le point de vue de leur classification botanique et de leur distribution geologique., L. Martinet, Paris : 1-127.

Chapman, F. (1908). Report on Jurassic plants. *Rec. geol. Surv. Vict.*, **2**(4) : 212-220.

Corsin, P. & Stampfli, G. (1977). La Formation de Shemshak dans L' elburz oriental (Iran) Flora-Stratigraphie-Paleogic graphie. *Geobios*, **10**(4) : 509-571.

Doludenko, M. P. & Svanidze, T. I. (1969). The late Jurassic Flora Georgica. *Acad. Sci. U.S.S.R. Trans.*, **178** : 1-116.

Fiestmantel, O. (1879). The fossil flora of the Upper Gondwanas : Outliers on the Madras Coast. *Mem. geol. Surv. India Palaeont. indica.*, ser. 2, **1**(4) : 191-1223.

Fliche, M. P. (1900). Contribution ala flora fossile de la Haute-Marne (Infracretace). *Bull. Soc. Sci. Nancy* : 1-23.

Gupta, K. M. (1954). Notes on some Jurassic plants from the Rajmahal Hills, Bihar. India *Palaeobotanist*, **3** : 18-26.

Halle, T. G. (1913). The Mesozoic flora of Graham Land. *Wiss. Ergebn. Schwed. Sudpolar Exped.*, **3**(14) : 1-123.

Harris, T. M. (1964). The Yorkshire Jurassic Flora-**II**. Caytoniales, Cycadales and Pteridosperms. *Br. Mus. nat. Hist. Lond.*, : 1-191.

Harris, T. M. (1969). The Yorkshire Jurassic Flora III. Bennettitales. *Br. Mus. nat. Hist. Lond.*, 1-86.

Heer, I. (1881). Contributions a la flora fossile du portuagal. *Comm. Trab. Geol. Portugal* : 1-15.

King, W. (1988). The geology of the Pranhita-Godavari Valley. *Mem. geol. Surv. India.*, **18**(3) : 1-150.

Kumar, P. (1973). The sporae dispersae of Jabalpur Stage, Upper Gondwana, India. *Palaeobotanist*, **20** (1) : 91-126.

Kutty, T. S. (1969). Some contributions to the stratigraphy of the Upper Gondwana formations of the Pranhita-Godavari Valley, Central India. *J. geol. Soc. India*, **10**(1) : 33-48.

Mahabale, T. S. (1967). Mesozoic floras of India—The Kota-Maleri Stage. *Palaeobotanist*, **15**(3) : 308-313.

Mahabale, T. S. & Satyanarayana, T. (1979). Upper Gondwana plant fossils from East Godavari District in Andhra Pradesh, India. *Geophytology*, **9**(1-2) : 65-82.

Maheshwari, H. K. & Kumaran, K. P. N. (1976). Some new conifer remains from the Jabalpur Group. *Palaeobotanist*, **23**(1) : 30-39.

Maheshwari, H. K. & Singh, N. P. (1976). On some plant fossils from the Pariwar Formation, Jaisalmer Basin Rajasthan. *Palaeobotanist*, **23**(2) : 116-123.

Morris, J. (1940). Appendix, in Capt. Grant's C. W. Memoir to illustrate the geological map of Cutch. *Trans. geol. Soc. Lond.* ser. 2, **5**(2) : 289-329.

Oishi, S. (1940). The Mesozoic floras of Japan. *J. Fac. Sci. Hokkaido Univ.* (*Sapporo*) IV, **5**(2-4) : 124-280.

Oldham, J. (1863). *In :* Oldham, T. & Morris, J. Fossil flora of the Rajmahal Series in the Rajmahal Hills, (1863). *Mem. geol. Surv. India Palaeont. indica*, ser. 2, **1**(1) : 1-52.

PAL, A. K., GHOSH, S. C., DATTA, P. M. & SHOME, S. (1985). A new species of *Cycadolepis* Saporta from the Gangapur Formation, Andhra Pradesh, India. (Abst.) *Proc. VI. Indian geophytological Conf., Lucknow.*

PASCOE, E. H. (1959). *A Manual of Geology of India and Burma* II : 909-1064.

PRESL (1938). In Sternberg, C. *Ver. such einger, geognostisch-botanischen Darstollung der Flora der Vorwelt Fasc.* 1-8, (1820-1938), Leipzig.

RAIVERMAN, V. (1986). Depositional model of Gondwana sediments in Pranhita-Godavari Graben, South India. *Bull. Geol. Nin. metall. Soc., India* **54** : 69-90.

RAJESHWAR RAO, P. V. & RAMANUJAM, C. G. K. (1979). The genus *Contignisporites* from the Lower Cretaceous, Gangapur beds of Adilabad District, A. P. *Geophytology*, **9** : 139-143.

RAJESHWAR RAO, P. V., RAMANUJAM, C. G. K. & VERMA, Y. N. R. (1983). Palynology of the Gangapur beds, Pranhita-Godavari Basin, Andhra Pradesh, *Geophytology*, **13**(1) : 22-45.

RAMAKRISHNA, H. & MURALIDHAR RAO, G. (1986). *Pterophyllum medlicottianum* from the Gangapur Formation of Andhra Pradesh. *Curr. Sci.*, **55**(23) : 1199-1200.

RAMANUJAM, C. G. K. & RAJESHWAR RAO, P. V. (1979). Palynological approach to the study of some Upper Gondwana clays at Ralapet near Asifabad in Adilabad District of Andhra Pradesh. *Geol. Surv. India. misc. Publ.* 45-60.

RAMANUJAM, C. G. K., & RAJESHWAR RAO, P. V. (1980). Palynological evidence for the age of some Upper Gondwana deposits in Adilabad District of Andhra Pradesh. *Proc. IV int. Palynol. Conf. Lucknow* (1976-77) **2** : 386-391. Birbal Sahni Institute of Palaeobotany, Lucknow.

RAO, C. N. & SHAH, S. C. (1960b). A note on the fossil flora of the Chikiala beds, Pranhita-Godavari Valley. (*Abst.*) Proc. 47*th Indian Sci. Congr.*, **3** : 279.

ROY, S. K. (1963). Studies on the Mesozoic flora of Kutch and Kathiawar-I. *Ptilophyllum horridum* sp. nov. *Proc.* 50*th Indian Sci. Congr.*, **3** : 396.

ROY, S. K. (1967). *Ptilophyllum horridum* sp. nov. from Trambau Kutch, *Curr. Sci.*, **36**(21) : 581-582.

ROY, S. K. (1968). Pteridophytic remains from Kutch and Kathiawar, India. *Palaeobotanist*, **16**(2): 108-114.

RUDRA, D. K. (1972). A discussion on the Kota Formation of the Pranhita-Godavari Valley, Deccan. *Q. Jl geol. Min. metall. Soc. India*, **44**(4) : 213-216.

SAHNI, B. (1928). Revisions of Indian fossil plants. Part-I Coniferales (a Impressions and Incrustations). *Mem. geol. Surv. India Palaeont., India* (n.s. **11** : 1-49.

SEWARD, A. C. & HOLTTUM, R. E. (1922). Jurassic plants from Ceylon. *Q. Jl geol. Soc. Lond.*, **78**(3) : 271-277.

SHAH, S. C., SINGH, GOPAL & GURURAJA, M. N. (1973). Observations on the Post-Triassic Gondwana sequence of India. *Palaeobotanist*, **20**(2) : 221-237.

SHAH, S. C. & SINGH, GOPAL (1974). Palynology of the Gangapur Formation, Pranhita- Godavari Basin, India. (Abt.,) *Proc. 45th Colloq. Indian microplaeont. Stratigr.*, Inst. Petrol. Explor. ONGC, Denradun.

SINGH, H. P. (1966). Reapparisal of the mioflora from the Jabalpur Series of India with remarks on the age of the beds. *Palaeobotanist*, **15**(1-2) : 87-92.

SINGH, H. P. (1974). Jurassic-Lower Cretaceous Mioflora. *In :* Surange K. R. *et al.*, (Eds.)*Aspects and Appraisal of Indian Palaeobotany*, 199-205, Birbal Sahni Institute of Palaeobotany, Lukcnow.

SITHOLEY, R. V. (1944). Jurassic plants from the Tabbowa Series in Ceylon. *Spolia zeylen.*, **24**(1) : 3-17.

SITHOLEY, R. V. (1963). Gymnosperms of India-I. *Bull notn. bot. Gdn, Lucknow*, **86** : 1-78.

SRIVSATAVA, G. K., NAUTIYAL, D. D. & PANT, D. D. (1984). Some coniferous shoots from Bansa beds of the Jabalpur Formation (Lower Cretaceous). *Palaeontographica*, **194B** : 131-150.

SUKH-DEV (1961). The fossil flora of Jabalpur Series-3. Spores and pollen grains. *Palaeobotanist*, **8** : 43-56.

SUKH-DEV & BOSE, M. N. (1974). On some conifer remains from Bansa, South Rewa Gondwana Basin. *Palaeobotanist*, **21** (1) : 59-69.

SUKH-DEV & ZEBA-BANO (1969). Observations on the genus *Allocladus* and its representatives in the Jabalpur Formation. *Palaeontographica*, **168B** (4-6) : 116-121.

SUKH-DEV & ZEBA-BANO (1981). Fossil gymnosperms from the Satpura Basin, Madhya Pradesh, India. *Palaeobotanist*, **27**(1) : 1-11.

TOWNROW, J. A. (1965). A new member of the Corystospermaceae Thomson. *Ann. Bot.*, **29**(115) : 495-510.

TOWNROW, J. A. (1967). The *Brachyphyllum crassum* complex of fossil conifers. *Papl. Proc. R. Soc. Tasm.*, **101**, 144-172.

TRIPATHI, C. (1975). Observations on the Maler'-Kota beds of the Adilabad District, Andhra Pradesh. *Rec. geol. Surv. India.*, **106**(2) : 1-12.

VENKATACHALA, B. S. & KAR, R. K. (1970). Palynology of the Mesozoic sediments of Kutch, W. India, 10. Palynological Zonation of Katrol (Upper Jurassic) and Bhuj (Lower Cretaceous) sediments in Kutch, Gujarat. *Palaeobotanist*, **18**(1) : 75-86.

VENKATACHALA, B. S. SHARMA, K. D. & JAIN, A. K. (1972). Palynological zonation of Jurassic-Lower Cretaceous sediments in the subsurface of Cauvery Basin. *In :* Ghosh *et al.*, (Eds.) *Proc. Sem. Palaeopalynol. Indian Stratigr.*, 1971, Bot. Dept., Calcutta Univ., : 172-187.

VISHNU-MITTRE (1959a). Studies on the fossil flora of Nipania (Rajmahal Series), Bihar—Coniferales. *Palaeobotanist*, **6**(2) : 82-112.

WESLEY, A. (1956). Contribtutions to the knowledge of the flora of the Grey Limestones of Veneto. Part-I. *Memorie Ist geol. miner. Univ. Padova*, **12** : 1-168.

Explanation of Plates

Plate 1

1. *Taeniopteris spatulata*, Specimen no. B.S.I.P 36185 × 1
2. *Cladophledis* sp , Specimen no. B.S.I.P. 36183 ×2.
3. *Pachypteris gangapurensis* n.sp., Holotype, Specimen, no. B.S.I.P. 36184 ×1.
4. Same, enlarged, ×?
5. *Pachypteris gangapurensis*, papillae on the lower surface of leaf, Slide no. B.S.I.P. 36184-I ×500.
6. *Ptilophyllum horridum* Roy, Specimens B.S.I.P. 36191 ×1.
7. *Pachypteris gangapurensis* n.sp. showing stomata on lower surface of leaf, Slide no. B.S.I.P. 36184-I ×500.
8. Same, showing distribution of papillae on lower surface of leaf, Slide no. B.S.I.P. 36184-I ×150.

Plate 2

1,2. *Ptilophyllum distans* (Feistmantel) Jacob & Jacob, Specimen nos. B.S.I.P. 36190, 36214 ×1.
3. *Ptilophyllum distans*, stomata, Slide no. B.S.I.P. 36190-I, ×500.
4. Same showing distribution and orientation of stomata on lower surface of leaf, ×150.
5. *Ptilophyllum horridum* Roy, Specimen no. B.S.I.P. 36215 ×1.
6. Same, Lower surface of leaf showing banded distribution of stomata with papillae, slide no. B.S.I.P. 26215 ×150.

Plate 3

1. *Dictyozamites gondwanaensis* n.sp. stomata, Scanning microphotograph, Specimen no. B.S.I.P. 36195A. ×900
2. *Ptilophyllum distans* (Feistmantel) Jacob & Jacob stomata, Scanning microphotograph, Specimen no. B.S.I.P. 36190 ×500.
3. Same, scanning microphotograph, × 1500.

Plate 4

1,2. *Ptilophyllum* sp., Specimen nos. B.S.I.P. no. 36192, 36193 ×1.
3. *Ptilophyllum acutifolium* Morris. Specimen no. B.S.I.P. no. 36186 ×1.
4. *Ptilophyllum* sp., Specimen no. B.S.I.P. 36914 ×1.
5-7 *Ptilophyllum cutchense* Morris, Specimen nos. B.S.I.P. 36187, 36188, 36189 ×1.
8. *Ptilophyllum cutchense*, venation, Specimen, no. B.S..I.P. 36179 ×4.

Plate 5

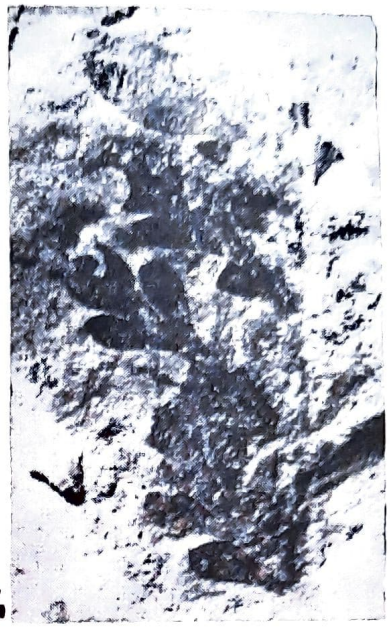
Dictyozamites gondwanaensis n. sp.

1. Holotype, Specimen no. B.S.I.P. 36195A ×1.
2. Specimen no. B.S.I.P. 36195 B ×1.
3. Lower cuticle of leaf, showing stomata and papillae, slide no. B.S.I.P. 36195B× 500.
5. Pinnae showing venation, Specimens B.S.I,P. 36195 B ×4.

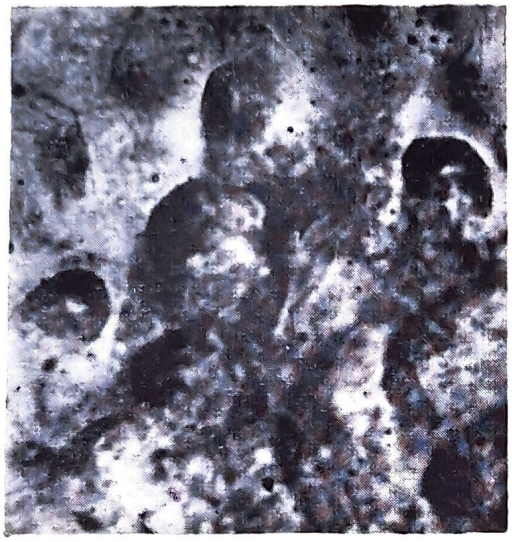
1

2

3

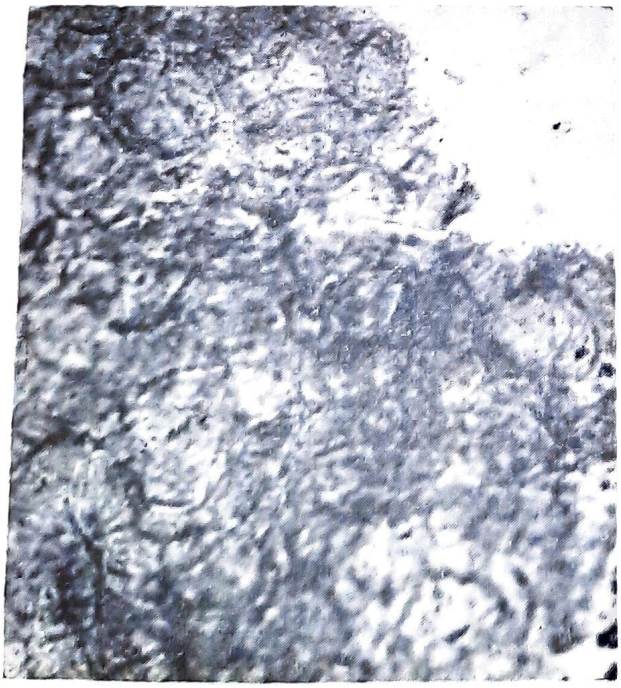


4

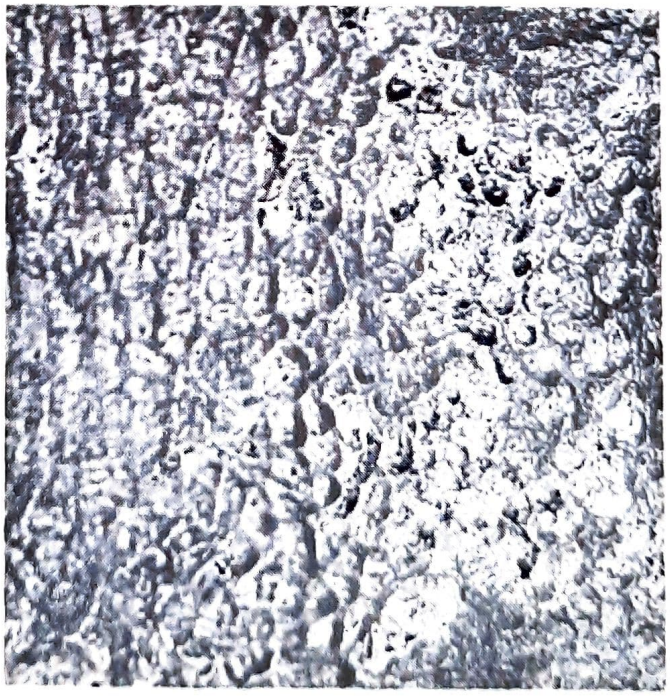


5

6



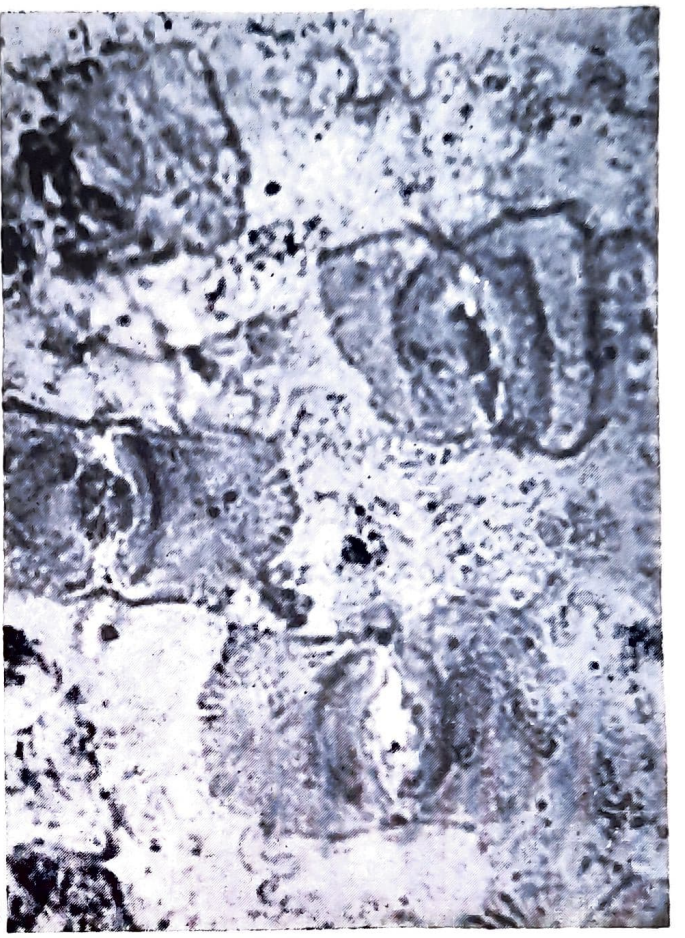
7



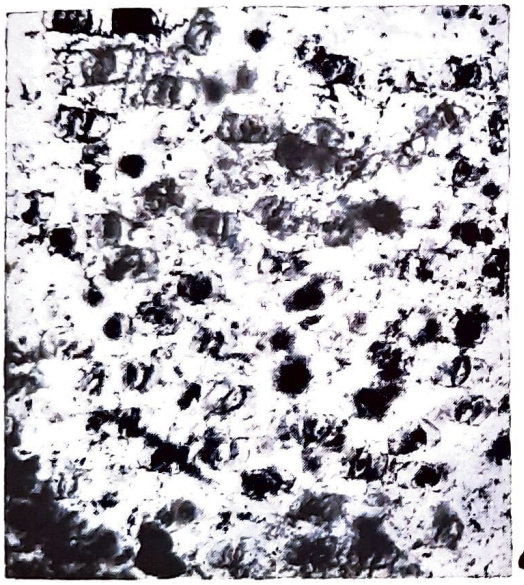
8

1

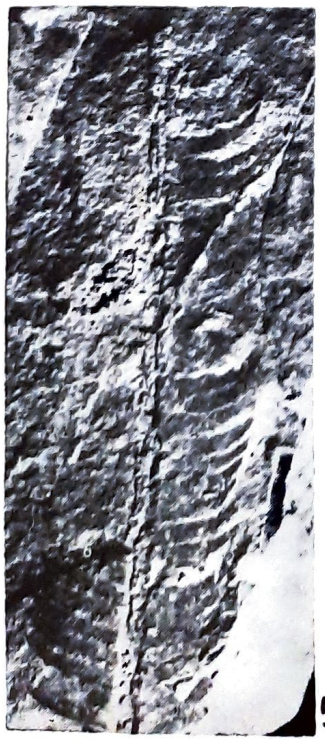
2



3



4

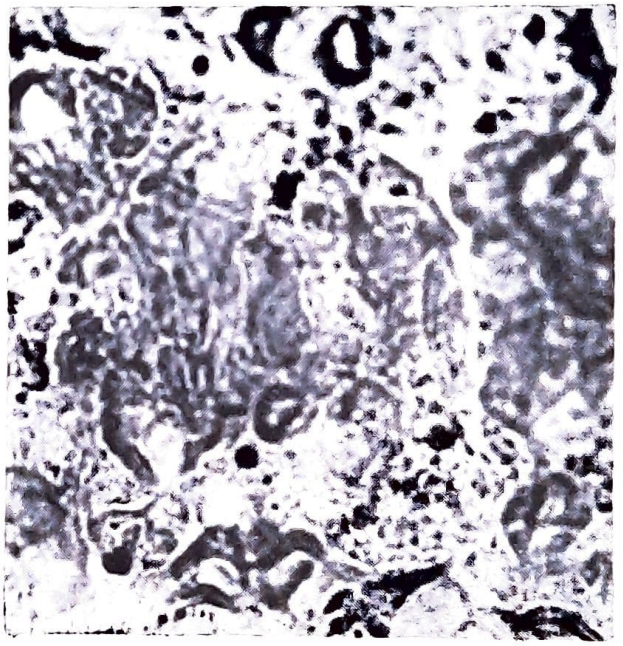


5

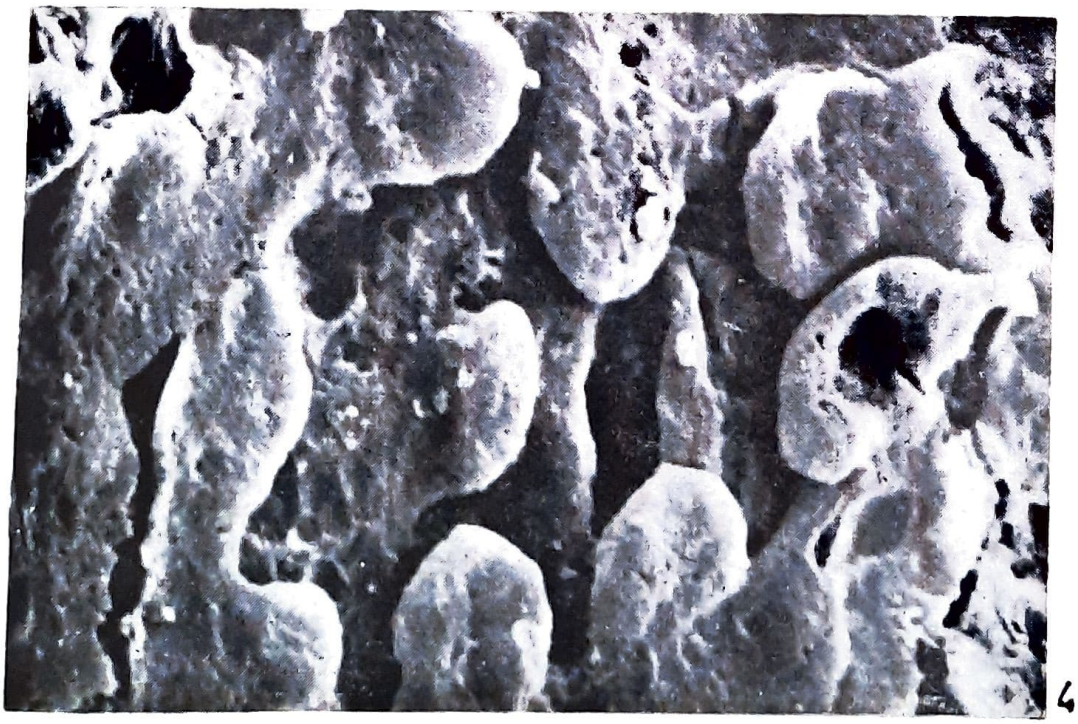
6

1

2



3



4

1

2

4

5

3

6

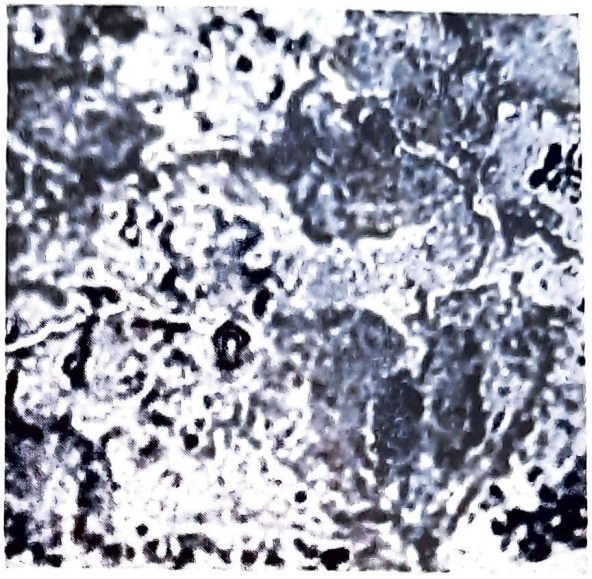
7

8

Sukh-Dev & Rajanikanth—Plate 4

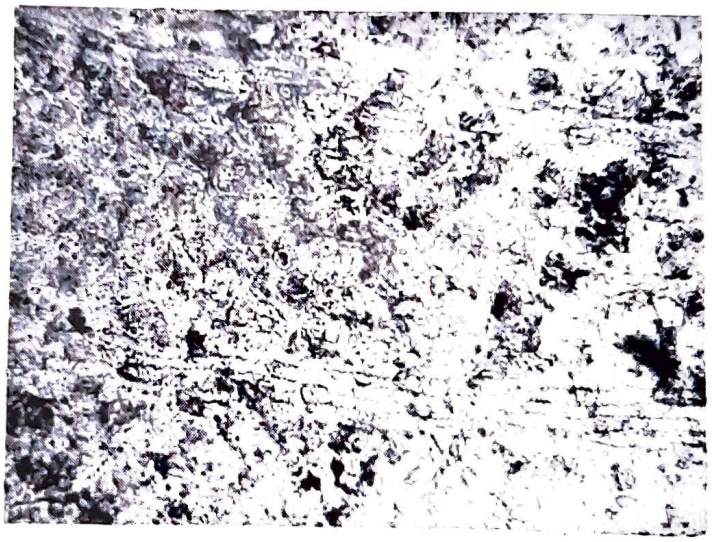
1

2

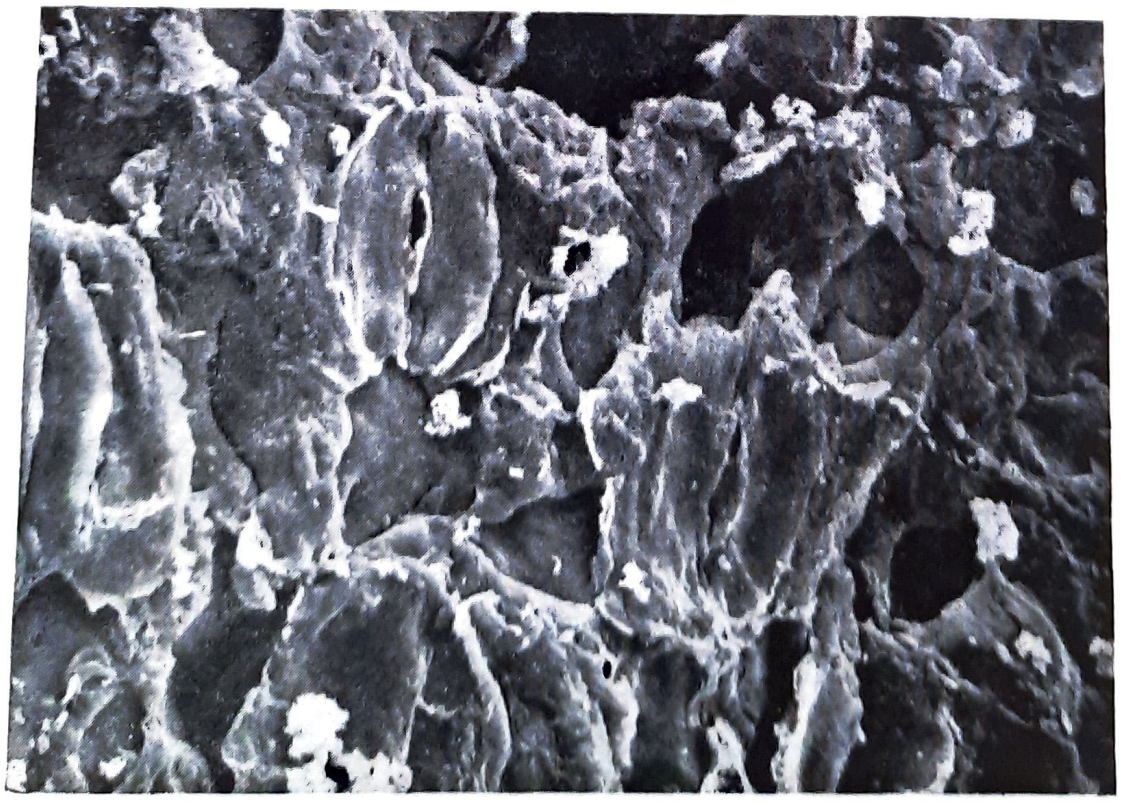


3

4



5



6

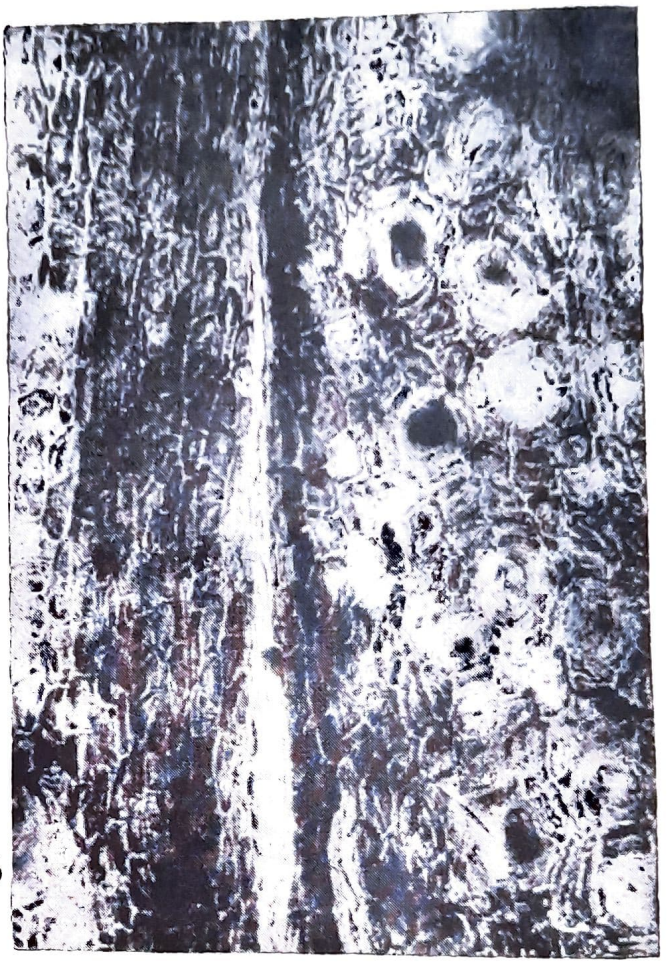
1

2

3

4

5



6

7

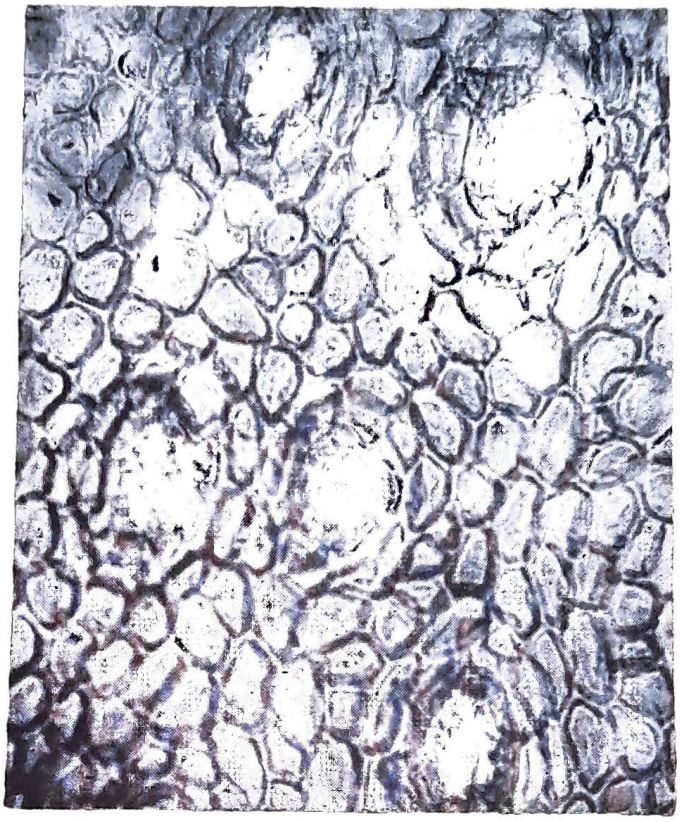
8

Sukh-Dev & Rajanikanth—Plate 6

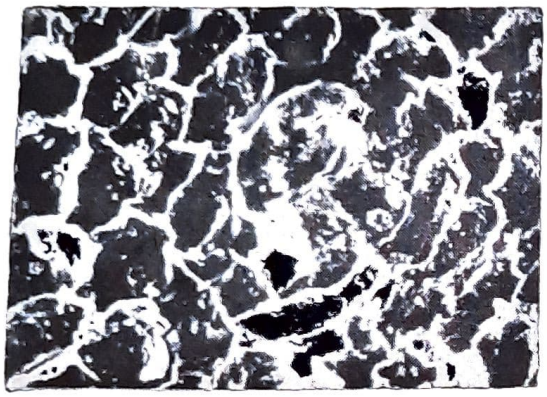
1

2

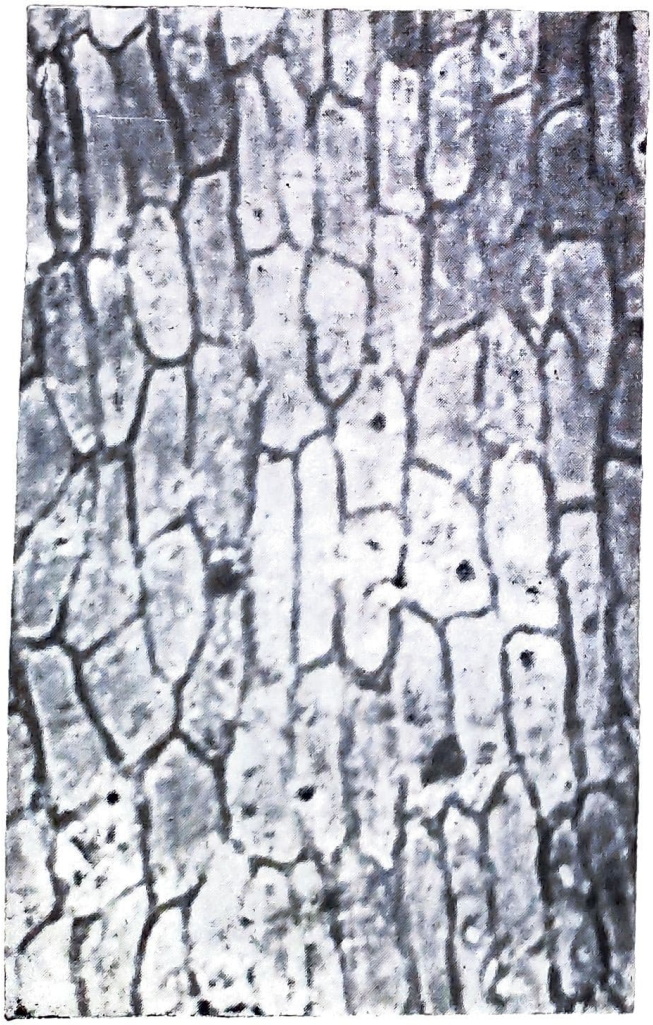
3



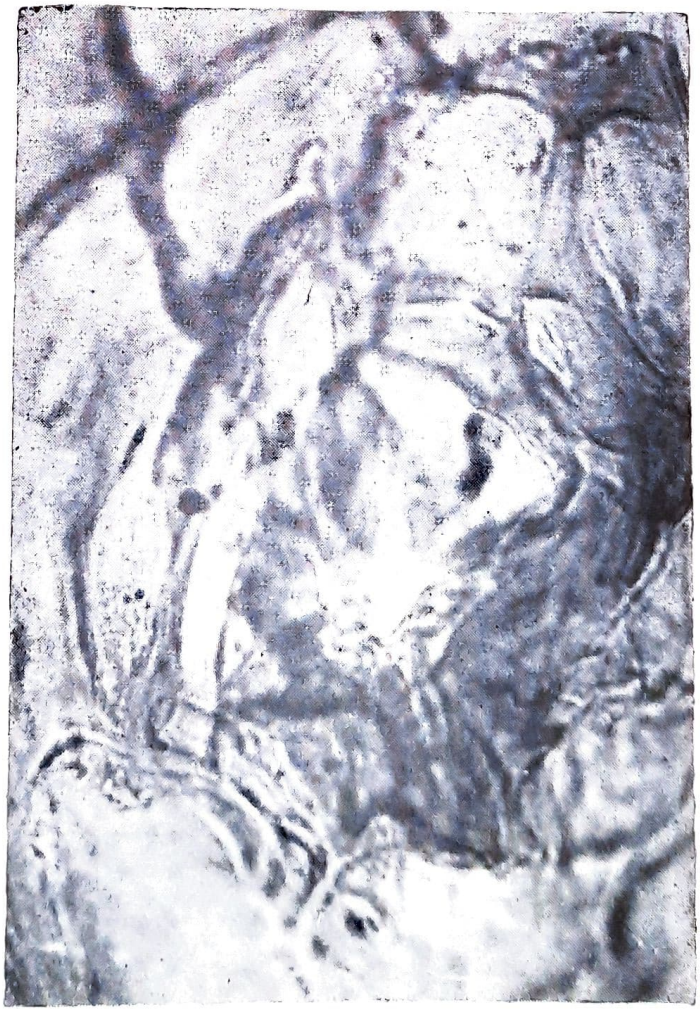
4



5

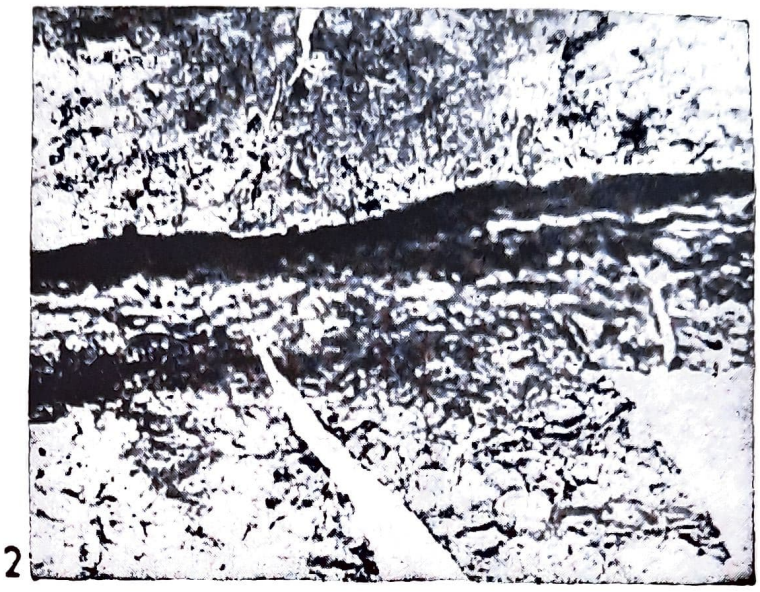


6

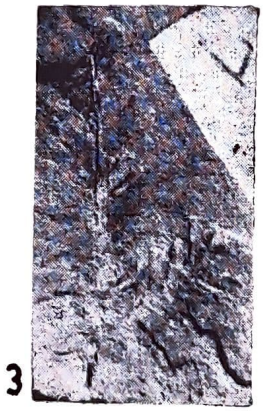


7

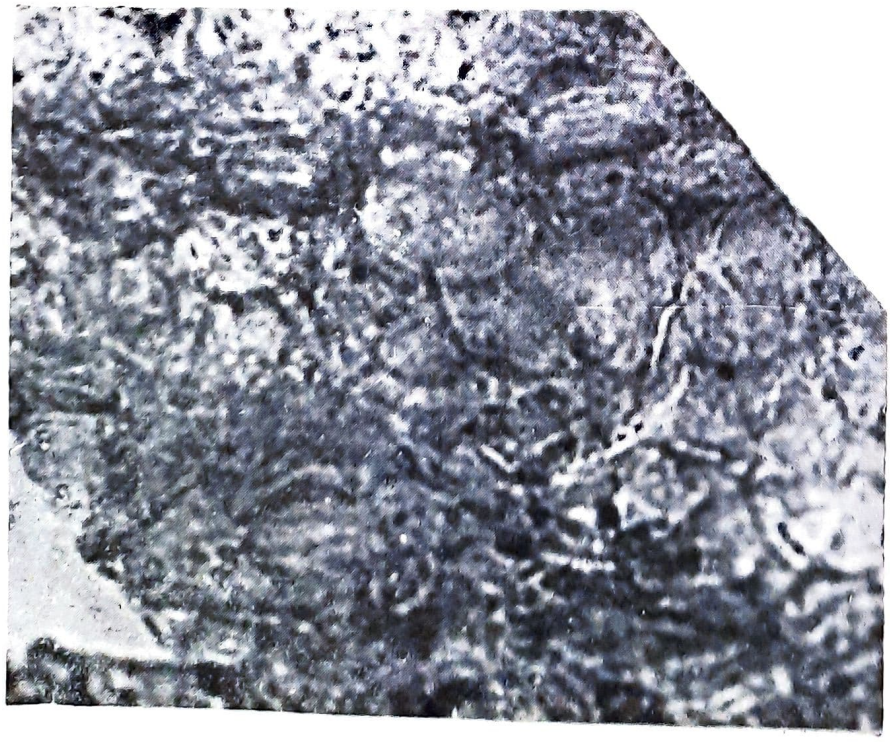
1



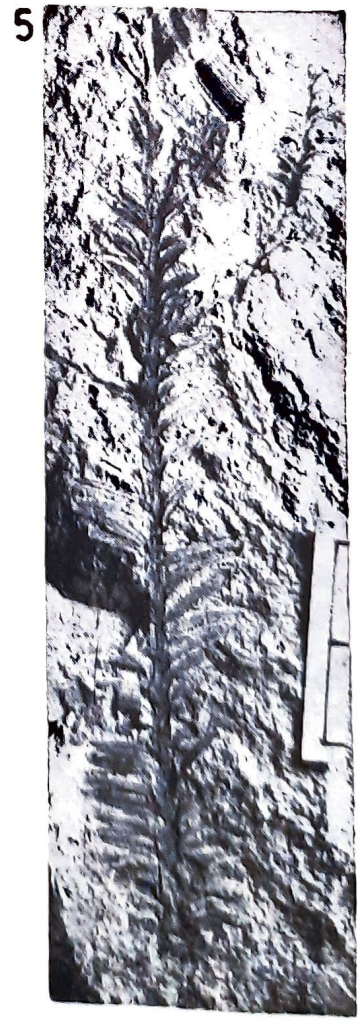
2



3



4



5

Sukh-Dev & Rajanikanth—Plate 8


1


2


3


4


5


6


7


8

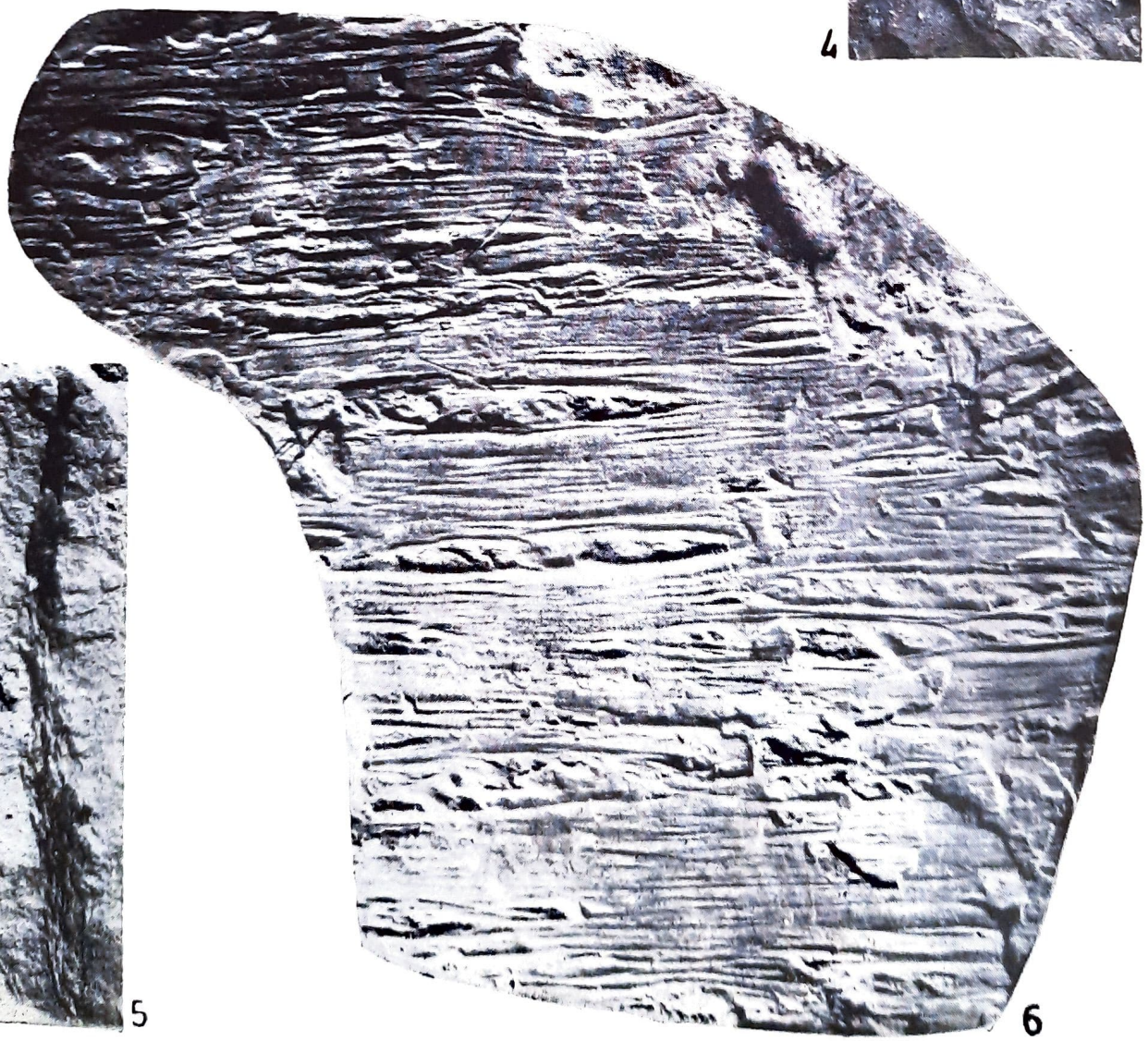
1

2

3

4

5



6

Sukh-Dev & Rajanikanth—Plate 10

Plate 6

1. *Pagiophyllum* sp. Specimen no. B.S.I.P. 36204 × 1.
2,3. *Pagiophyllum marwarensis* Bose & Sukh-Dev, Specimen no. B.S.I.P. 36202 × 1.
4. *Pagiophyllum spinosum* n.sp. Holotype Specimen, no. B.S.I.P. 36203 × 1.
5. *Pagiophyllum* sp. enlarged B.S.I.P. no. 36204 × 2.
6. *Pagiophyllum marwarensis* Bose & Sukh-Dev., both the surfaces a of leaf, Slide no. B.S.I.P. 63200-I × 150.
7. Same, two stomata, × 500.
8. Same, scanning microphotograph of a stoma, ×900.

Plate 7

Brachyphyllum sehoraensis Bose & Maheshwari

1. Specimem no. B.S.I.P. 36206 × 1.
2,3 Specimen no. B.S.I.P. 36206 × 1, × 2.
4. Lower cuticle of leaf showing distribution and orientation of stomata. Slide no. B.S.I.P. 36206-I × 150.
5. Scanning microphotograph of a stoma, Specimen no. B.S.I.P. 36206 × 300.
6. Upper cuticle, Slide no. B.S.I.P. 36206-II × 500.
7. A stoma magnified, Slide no. B.S.I.P. 36206-1 × 500.

Plate 8

1. *Elatocladus confertus* (Oldham & Morris) Halle, Specimen no. B.S.I.P. 36196 × 1.
2. *Elotocladus* sp.A. Lower and upper surfaces of leaf, Slide no. B.S.I.P. 36200-I × 150.
3. *Elatocladus* sp.A. Specimen no. B.S.I.P. 36200 × 1.
4. *Elatocladus* sp. A, a stoma magnified, Slide no B.S.I.P. 36200-I × 500.
5. *Elatocladus confertus* (Oldham & Morris) Halle, Specimen no. B.S.I.P. 36197 × 1.

Plate 9

1. *Elatocladus confertus* (Oldham & Morris) Halle, Specimen no. B.S.I.P. 36198 × 2.
2. *Araucarites cutchensis* Feistmantel, Specimen no. B.S.I.P. 36209 × 1.
3-5. *Araucarites minutus* Bose & Maheshwari, Specimen no. B.S.I.P. 36211 × 1, 36210 × 1, 36211 × 2.
6,7. *Allocladus bansaensis* Sukh-Dev and Zeba-Bano. Specimen no. B.S.I.P. 36207 × 2 (a portion enlarged × 1).
8. *Elatocladus confertus* (Oldham Morris) Halle, Specimen no. B.S..I.P. 36198 × 1.

Plate 10

1,2. *Elatocladus* sp. B., Specimen no. B.S.I.P. 36201 × 2, × 1.
3. *Coniferocaulon rajmahalense* Gupta, Specimen no. B.S.I.P. 36212.
4. *Elatocladus confertus* (Oldham & Morris) Halle, Specimen no. B.S.I.P. 36199 × 1.
5. *Allocladus bansaensis* Sukh-Dev & Zeba-Bano, Specimen no. B.S.I.P. 36208 × 1.
6. *Coniferocaulon rajmahalense* Gupta, Specimen no. B.S.I.P. 76213 × 1.