SOME NEW CONIFER REMAINS FROM THE JABALPUR GROUP

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ABSTRACT

Three new species of *Elatocladus* (viz., *E. pseudotenerrima*, *E. sehoraensis* and *E. bosei*), and two new species of *Pagiophyllum* (viz., *P. sherensis* and *P. satpuraensis*) are described from the Jabalpur Group exposed in the Sher River near Sehora, District Narsinghpur, Madhya Pradesh. All these species are based upon their epidermal as well as morphological features.

INTRODUCTION

IN the Jurassic-Lower Cretaceous beds of India, the conifers are fairly well represented and most of them show affinities with either Podocarpaceae or Araucariaceae. Some forms have also been referred to the families Taxaceae and Taxodiaceae but their affinities are as yet not clear. A summary review of the Mesozoic conifer remains from India has recently been presented by Bose and Maheshwari (1974).

In the present paper some new species of the genera *Elatocladus* and *Pagiophyllum*, having affinities with the families Podocarpaceae and Araucariaceae respectively, have been described. About 200 specimens were studied, of which about one-half yielded cuticles.

DESCRIPTION

Genus—*Elatocladus* Halle, 1913

Type Species — *Elatocladus heterophylla* Halle, 1913.

Elatocladus pseudotenerrima sp. nov.

Pl. 1, figs. 1-3; Text-fig. 1A-C

Diagnosis — Sterile conifer twig with an axis about 1·5 mm wide. Leaves inserted spirally but all lying in one plane, elongated, 5-7 mm long and less than 1·5 mm wide, dorsiventrally flattened, diverging at broad angles from axis. Leaf apex mostly obtuse, rarely bluntly pointed. Leaf base slightly contracted and more or less decurrent. Lamina with a single conspicuous median vein reaching up to the apex, frequently bent with leaf apex pointing backwards. Leaf margin entire and microscopically even.

Leaves hypostomatic. Cuticle of two sides markedly different in thickness. Upper epidermis comparatively thin, devoid of stomata. Cells large, longish rectangular in shape, mostly arranged end to end. Lateral walls thick and straight. Surface walls unspecialized. Lower epidermis thicker than the upper, cells almost 3 times longer than broad, polygonal or rectangular with more or less straight anticlinal walls. Surface wall flat, thin and devoid of pitting. Stomata rather widely spaced, monocyclic, distributed in two distinct bands leaving a central astomatic region, orientated longitudinally and arranged more or less in rows, adjacent stomatal rows 3-5 cells apart. Subsidiary cells 4-5 (usually 4). Guard cells more or less rectangular in shape, walls thickly cutinized. Stomatal aperture narrow, indistinct in some cases. Encircling cells absent.

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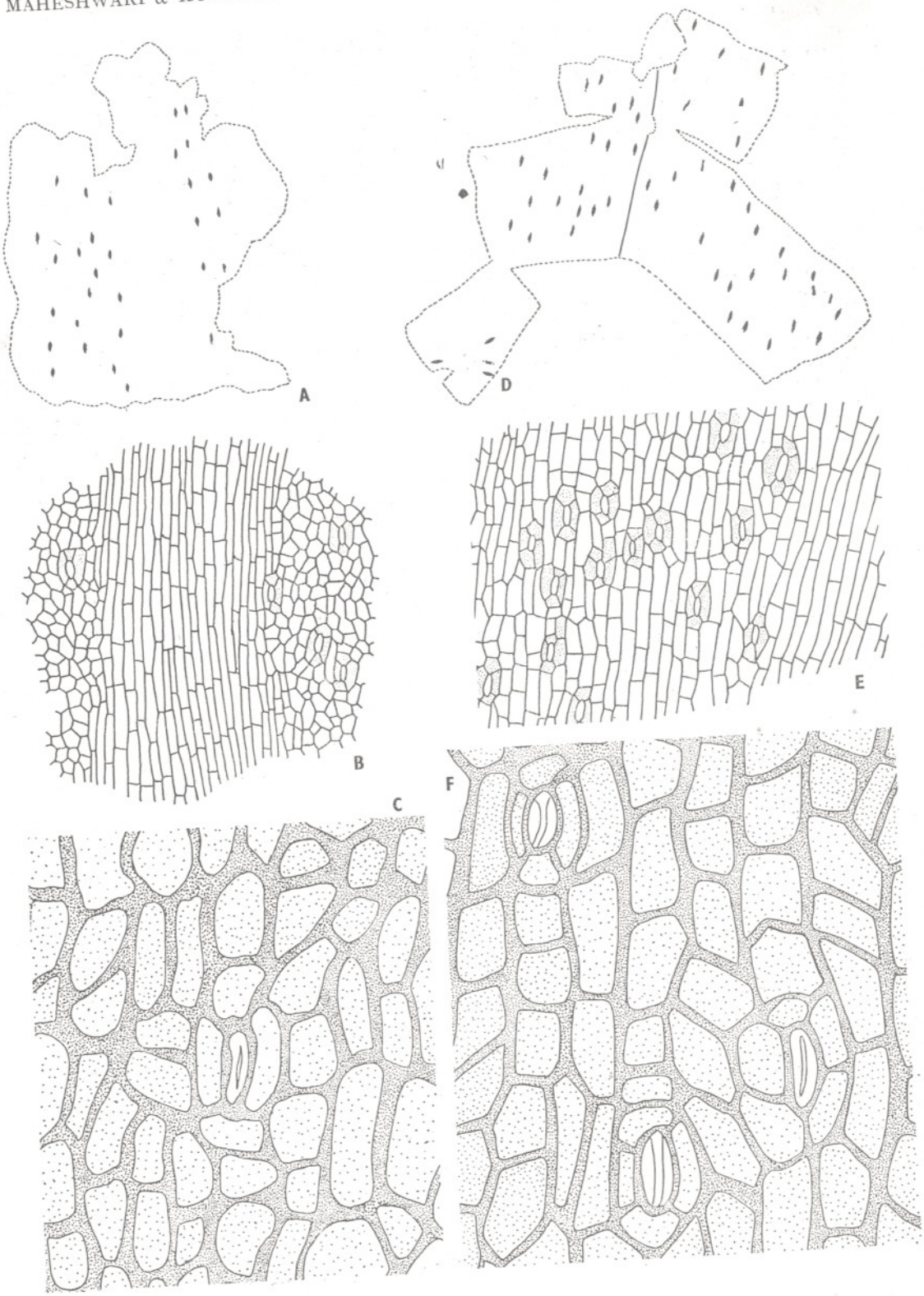
TEXT-FIG. 1 — A-C, *Elatocladus pseudotenerrima* sp. nov.: A, portion of the lower cuticle showing distribution and orientation of the stomata × 44; B, the lower cuticle showing parts of the two stomatic zones and the central astomatic zone × 110; C, a single stoma enlarged × 430. D-F, *Elatocladus bosei* sp. nov.: D, portions of the lower and upper cuticles near the leaf margin showing distribution and orientation of the stomata × 44; E, the lower cuticle enlarged × 110; F, a few stomata enlarged × 430.



TEXT-FIG. 1

Comparison — In external morphology, the new species is almost similar to *Elatocladus conferta* (Oldham & Morris) Sahni (1928) but it is easily distinguished from the latter by its well spread out leaves and obtuse apex. *E. sahnii* Vishnu-Mittre (1959) is also comparable in general appearance but the present species possesses pseudodistichous and more or less closely set leaves. The orientation of stomata also separates the two species from each other, stomata being irregularly scattered in *E. sahnii*. In its general appearance and distribution of stomata, the new species comes nearest to *E. tenerrima* (Feistmantel) Sahni (1928). However, *E. pseudotenerrima* shows bifacial leaves with prominent contraction of the leaf base and the stomata distributed in two distinct bands and orientated in longitudinal rows. On the other hand, in *E. tenerrima* the leaves are stiff and narrow, curved downwards without contraction and with a peculiar distribution of stomata, which are confined to the upper half of the vertically expanded lamina. The sessile stout leaves of *E. ushioi* Konn'o (1962) differ in being linear-lanceolate in shape with a thick midrib. *E. australis* Townrow (1967) has very thick leaves, margins of which are not quite parallel. *E. heterophylla* Halle (1913) differs by its dimorphic foliage with narrow linear and sharply acute leaves.

The hypostomatic leaves with stomata distributed in two distinct bands leaving a central astomatic region separate this species from the other known species of the genus *Elatocladus*.

Holotype — Specimen no. B.S.I.P. 124/926.

Type Locality — Sehora, on the Sher River, District Narsinghpur, Madhya Pradesh.

Horizon & Age — Jabalpur Group, ? Upper Jurassic.

Elatocladus sehoraensis sp. nov.

Pl. 1, figs. 4-5; Text-fig. 2A-C

Diagnosis — Slender, sterile conifer twigs. Shoot axes about 1·5 mm wide. Leaves spirally arranged, but well spreadout and directed outwards from the axis. Leaves elongated, 4-6 mm long and about 1-1·5 mm broad, dorsiventrally flattened into one plane, rather widely spaced. Apex obtusely pointed. Base slightly constricted. Midrib rather inconspicuous but can be seen in better preserved specimens. Leaf margins entire and microscopically even.

Leaves amphistomatic. Cuticle of the two surfaces of unequal thickness. Cells of the upper epidermis more compact, large and much broad. Cell walls very thick and more or less straight. Surface wall rarely pitted. Lower epidermis comparatively thick, cells much longer than broad, elongated-rectangular in shape and more or less arranged end to end. Pitting on surface wall very common. Stomata on one side in two distinct stomatal bands leaving a central astomatic region, while on the other surface stomata confined to a central region only. Stomata monocyclic, rarely dicyclic, orientated longitudinally and arranged in rows. Subsidiary cells mostly 4 in number (rarely 5), two polar and two lateral, surface wall thinly cutinized. Stomatal aperture very narrow and distinct.

Comparison — In its cuticular structure this species differs from both *Elatocladus tenerrima* (Feistmantel) Sahni (1928) and *E. sahnii* Vishnu-Mittre (1959) even though they show some morphological resemblances. Both *E. tenerrima* and *E. sahnii* possess stomata only on one surface, whereas in *E. sehoraensis* the leaves are amphistomatic. In *E. tenerrima*, the stomata are confined to the upper (i.e. acroscopic) half of the vertically expanded and thickened surface, whereas in *E. sehoraensis* stomata occur in distinct bands on both the surfaces. *E. sahnii* Vishnu-Mittre (1959) shows scattered distribution of stomata on the under surface and thus differs from *E. sehoraensis*. *E. sehoraensis* distinguishes from *E. pseudotenerrima* by its amphistomatic leaves with the peculiar distribution of stomata in distinct bands on one surface, while confined to a central band on the other surface.

Holotype — Specimen no. B.S.I.P. 53/926.

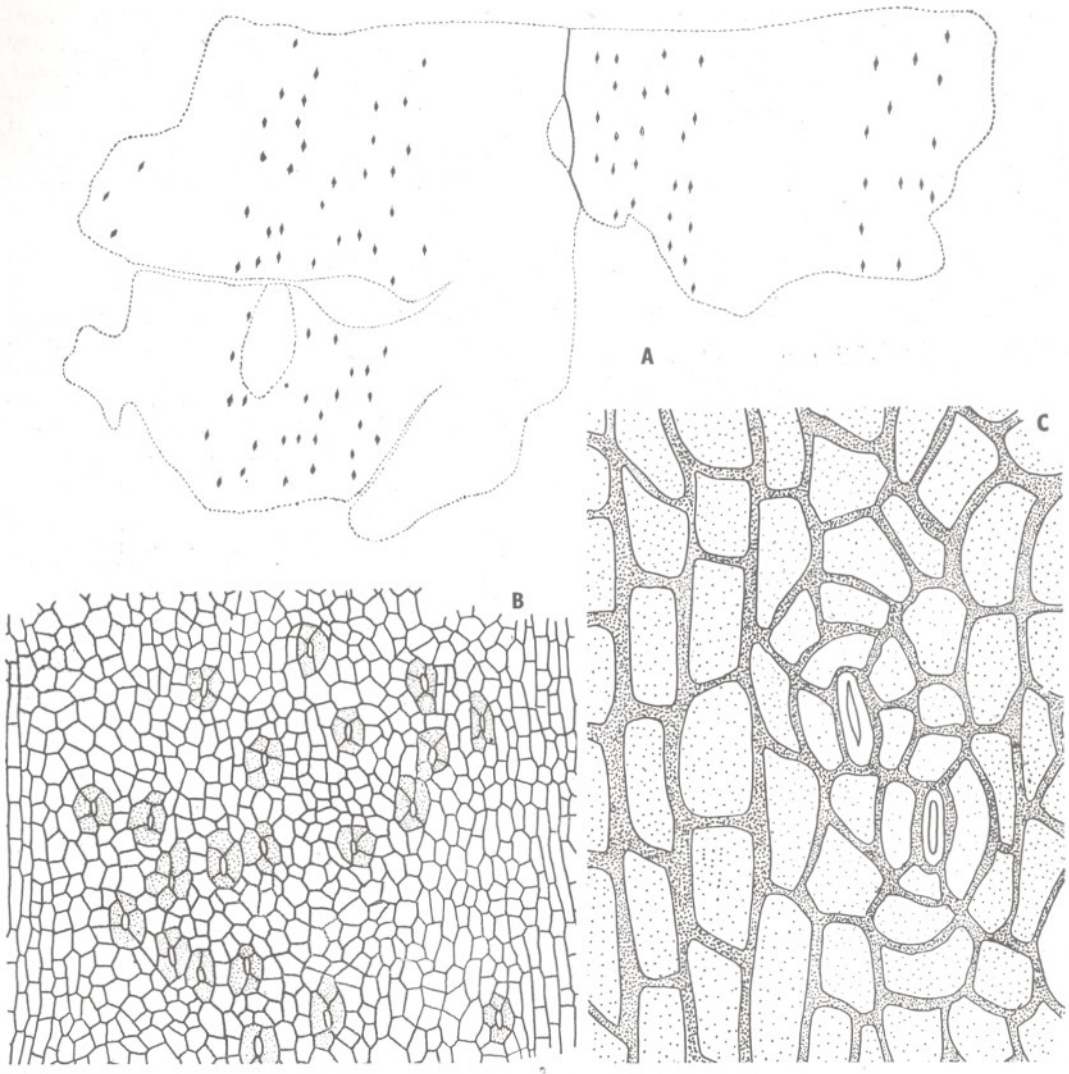
Type Locality — Sehora, on the Sher River, District Narsinghpur, Madhya Pradesh.

Horizon & Age — Jabalpur Group, ? Upper Jurassic.

Elatocladus bosei sp. nov.

Pl. 1, figs. 6-7; Text-fig. 1D-F

Diagnosis — Sterile, slender conifer twigs with axis about 1·5 mm wide. Leaves



TEXT-FIG. 2 — *Elatocladus sehoraensis* sp. nov.: A, portions of the lower and upper cuticles showing distribution and orientation of the stomata × 44; B, lower cuticle showing the central stomatal zone × 110; C, two stomata enlarged × 430.

spirally inserted on the axis, but directed outwards, flattened into one plane. Leaf dorsiventral, 3-5 mm long and less than 1 mm broad, apex obtusely pointed. Leaf base slightly narrow and constricted, decurrent. Midrib conspicuous and extending up to the apex. Leaf margins entire and even microscopically.

Leaves amphistomatic. Cuticle of both surfaces more or less of same thickness. Cells polygonal or rectangular in shape, walls thick, slightly wavy to straight. Cells of lower epidermis similar to the above, but cells comparatively shorter and broad. Surface wall rarely shows pitting. Stomata not forming bands, but on both surfaces tending to form rows. Stomata monocyclic, rarely partly dicyclic. Subsidiary cells 4-6 (commonly 4) in number, 2 polar and the rest lateral; surface wall thinly cutinized. A ring of broad and short cells rarely seen around the subsidiary cells. Guard cells large and sunken with thickened walls. Stomatal aperture distinct and slit-like.

Comparison — *Elatocladus bosei* resembles both *E. pseudotenerrima* and *E. sehoraensis* in its general appearance, but it differs from both in cuticular features. It is easily distinguished from *E. pseudotenerrima* by its amphistomatic leaves. The stomata are confined to distinct bands in *E. sehoraensis* whereas in *E. bosei* the stomata are evenly distributed on both the surfaces, even though both species share the feature of amphistomatic condition.

Holotype — Specimen no. B.S.I.P. 28943/331A.

Type Locality — Sehora, on the Sher River, District Narsinghpur, Madhya Pradesh.

Horizon & Age — Jabalpur Group, ?Upper Jurassic.

Genus — *Pagiophyllum* Heer, 1881

Type Species — *Pagiophyllum circinum* Heer, 1881.

Pagiophyllum sherensis sp. nov.

Pl. 2, figs. 8-11; Text-figs. 3A-D, 4A-B

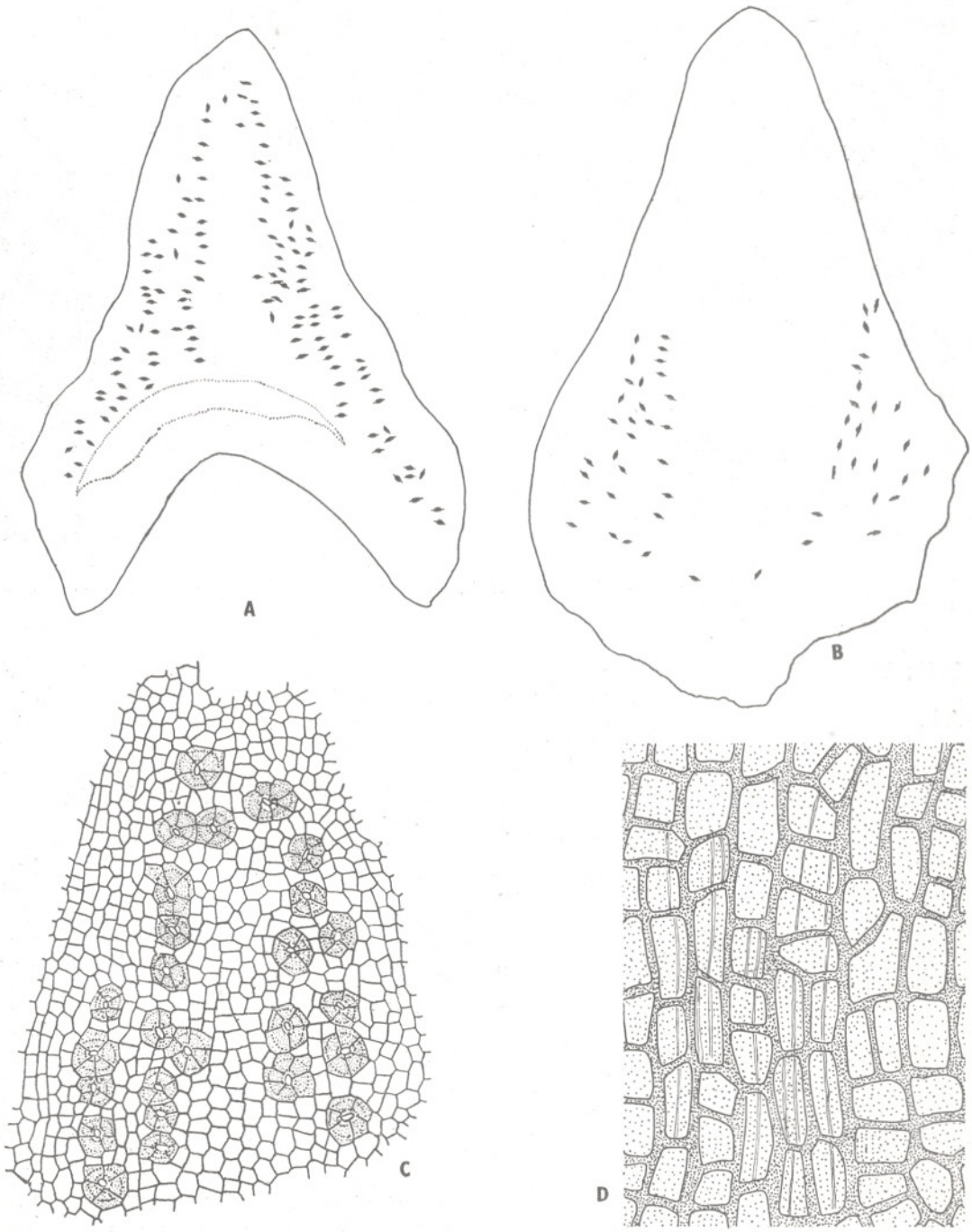
Diagnosis — Branched, leafy shoots. Leaves sessile, spirally disposed, crowded, directed forward or slightly spreading laterally. Leaves ovate to lanceolate, 3-4 mm long by 1·5-2 mm wide across expanded basal part, decurrent, apices narrowly pointed and commonly upturned giving a slight falcate appearance. Leaf base rounded, about 3 mm wide and concealed by the lower leaves. Margin entire.

Leaves amphistomatic, cuticle of both surfaces more or less of same thickness. Stomata more on the upper surface than the lower, in two distinct zones, leaving a central astomatic region, stomatic zones extending from basiscopic margin of leaf base towards acroscopic margin where these merge with each other. Stomata arranged in discontinuous linear rows, irregularly orientated. On the lower surface also stomata more or less in rows but occur only in the basal broadest part, a few stomata occur outside the rows. Ordinary epidermal cells rectangular or polygonal, serially arranged, marginal cells longer than broad. Surface walls sometimes show faint longitudinal striations. Lateral- and end-walls straight and uniformly thick throughout.

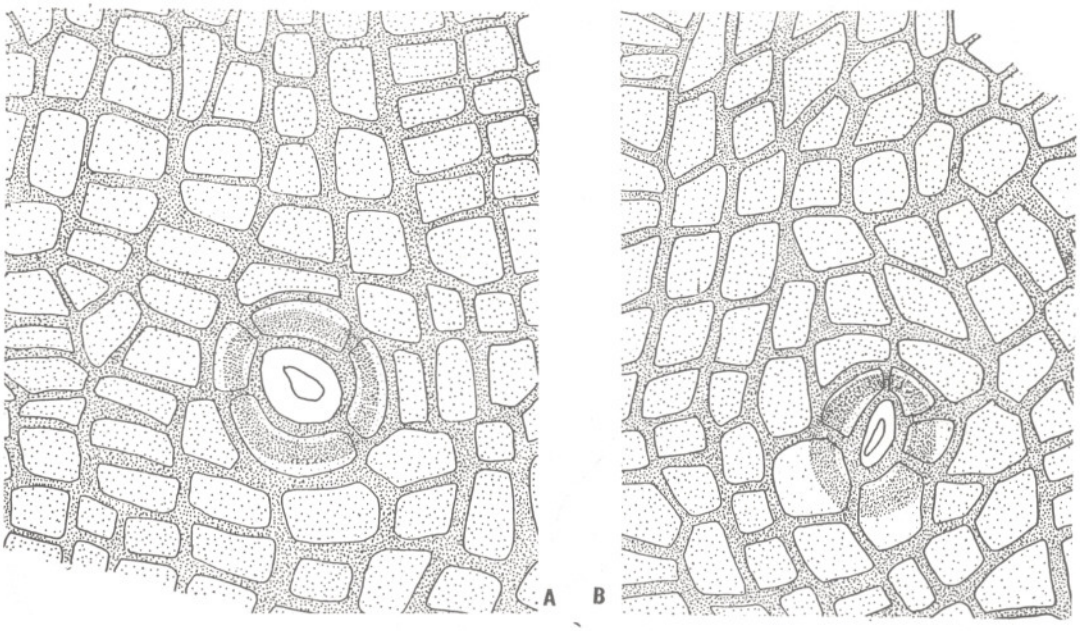
Stomata more or less circular, large, monocyclic, rarely dicyclic and irregularly orientated. Guard cells large, slightly more cutinized than the epidermal cells. Subsidiary cells 4-6 (mostly 5), two polar and the rest lateral, narrow, comparatively more cutinized than the epidermal cells. Occasionally two stomata sharing the subsidiary cells. The walls of subsidiary cells often continued into a cutin collar, projecting up and above the general epidermal level.

Comparison — In its external form and also in some of the cuticular features *Pagiophyllum sherensis* resembles *P. peregrinum* (L. & H.) Schenk (in, Sahni, 1928), and *P. bansaensis* Bose & Sukh-Dev (1971) described from the Jurassic and Cretaceous beds of India. However, *P. sherensis* differs in its slightly flattened slender shoot, the leaves of which are short and spreading. *P. peregrinum* described by Sahni (1928) has very small and comparatively less spreading leaves. The two species also differ from each other in the nature of stomatal distribution. In *P. sherensis* the upper side has more stomata but in *P. peregrinum* it is just the reverse. *P. sherensis* superficially resembles *P. marwarensis* Bose & Sukh-Dev (1971) in the arrangement and distribution of stomata. In both species the upper surface has more stomata which are arranged in two distinct zones, ultimately converging at the apex forming an arch over the central astomatic region. But in the former each stomatal zone of the upper surface is composed of comparatively less number of stomata. In *P. marwarensis* the cutin collar of the subsidiary cells is not seen.

In majority of the species of *Pagiophyllum* described by Wesley (1956), such as *P. rotzanum* (Massalongo) Wesley, *P. veronense* Wesley, *P. valdassense* Wesley, the stomata occur on both surfaces. However, *P. sherensis* can easily be distinguished from all the above species by the arrangement and distribution of stomata. In all the above species described by Wesley, stomata are distributed over most of the upper and lower surfaces whereas in *P. sherensis* the stomata occur in two distinct stomatic zones on the upper surface, while on the lower surface they are restricted to the basal region. Eight well defined species of *Pagiophyllum* are known from the Jurassic rocks of England (Kendall, 1948; Adams,



TEXT-FIG. 3 — *Pagiophyllum sherensis* sp. **nov.**: A, the upper cuticle showing the distribution and orientation of the stomata × 30; B, the lower cuticle showing the distribution and orientation of the stomata × 30; C, apical portion of the upper cuticle showing the apical convergence of the two stomatic zones × 75; D, the upper cuticle showing narrow longitudinal striations on the surface walls of the epidermal cells × 300.



TEXT-FIG. 4 — *Pagiophyllum sherensis* sp. nov.: A, a stoma with 4 subsidiary cells × 300; B, a stoma with 5 subsidiary cells × 300.

1951; Harris, 1952). The leaves in most of these are fairly large and *P. gracillimum* Adams is the only one which appears to be fairly close to *P. sherensis* in size and form. These two species, however, have significant microscopic differences, foremost of which is the distribution of stomata over most of the area on both the surfaces in *P. gracillimum*.

Holotype — Specimen no. B.S.I.P. 33883.

Type Locality — Sehora, on the Sher River, District Narsinghpur, Madhya Pradesh.

Horizon & Age — Jabalpur Group, ?Upper Jurassic.

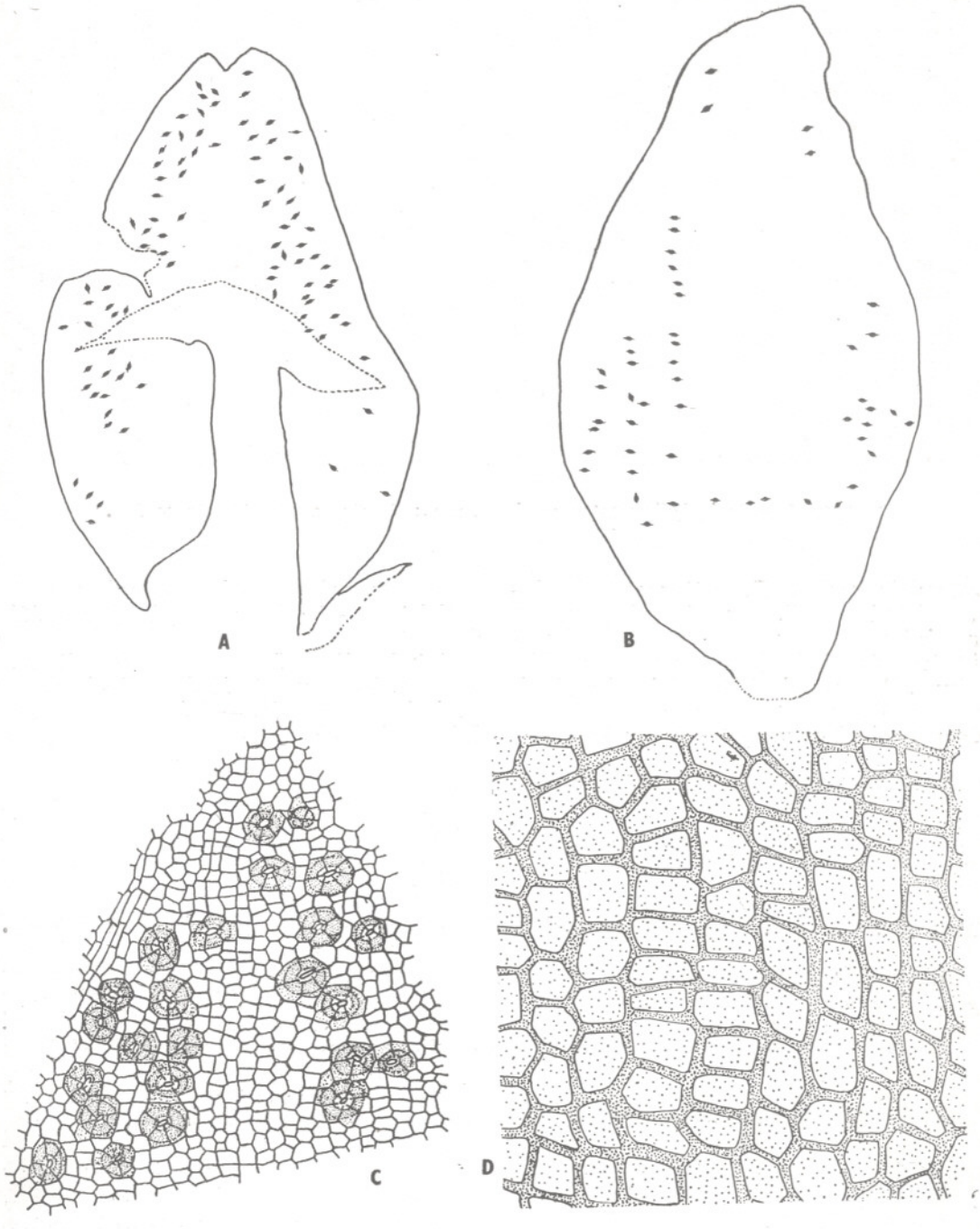
Pagiophyllum satpuraensis sp. nov.

Pl. 2, figs. 12-13; Text-figs. 5A-D, 6A-B.

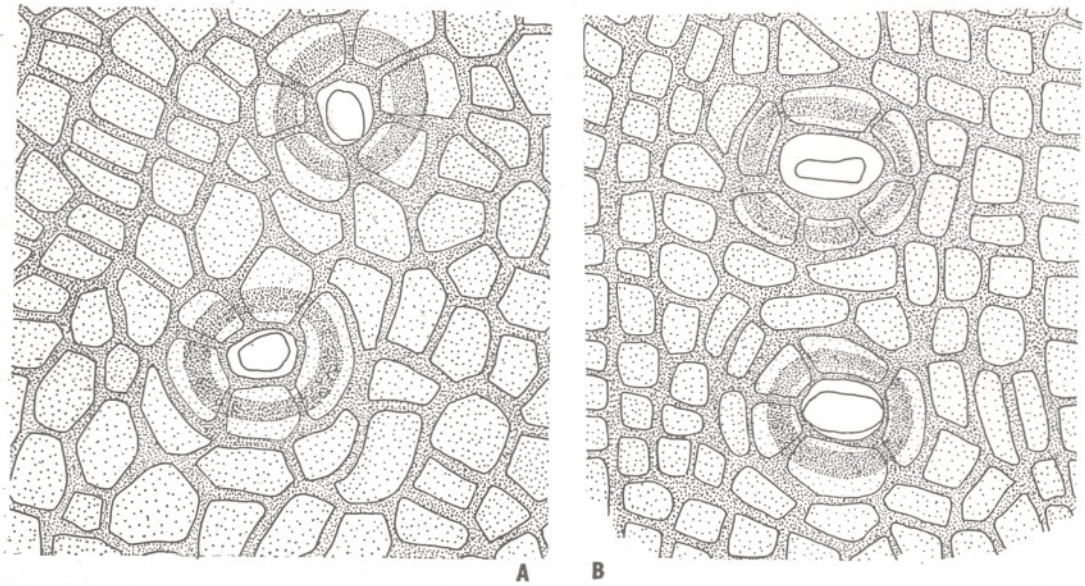
Diagnosis — Sterile twigs with relatively slender axes. Leaves sessile, obliquely ascending, spirally disposed, lanceolate, slightly falcate, directed forward or slightly spreading laterally. Individual leaf 4-5 mm long by about 2 mm wide across expanded basal part; leaf base decurrent. Apex acuminate. Free part of leaf spreading slightly incurved and tapered, longer than the broad base. Margin entire.

Leaves amphistomatic. Cuticle of medium thickness, similar on both surfaces of the leaf. On upper surface the stomata occur in two distinct zones, leaving a central astomatic region. On lower surface stomata confined to basal half only. Isolated stomata occur on the apical part of the surface which are independent from the basal discontinuous stomatal rows. Individual stomata more or less circular to oval and transversely orientated. However, oblique and longitudinal stomata not uncommon. Stomata sometimes dicyclic, and irregularly orientated inside the stomatal zone. Subsidiary cells 4-6 in number, slightly more cutinized than the ordinary epidermal cells. Guard cells strongly cutinized, slit distinct, spindle-shaped or wide. Ordinary epidermal cells rectangular or polygonal, arranged serially, lateral- and end-walls straight and more or less uniformly thick. Marginal cells longer than the other epidermal cells.

Comparison — *P. satpuraensis* resembles *P. sherensis* and *P. marwarensis* in the distribution of stomata on the upper side. In all these species, the stomata are confined to two distinct zones which continue from the base up to the apex where they converge and form an arch over the central



TEXT-FIG. 5 — *Pagiophyllum satpuraensis* sp. nov.: A, the upper cuticle showing the distribution and orientation of the stomata × 30; B, the lower cuticle showing the distribution and orientation of the stomata × 30; C, apical portion of the upper cuticle showing the convergence of the two stomatic Zones × 75; D, the upper cuticle showing ordinary epidermal cells × 300.



TEXT-FIG. 6 — *Pagiophyllum satpuraensis* sp. nov.: showing a few stomata × 300.

astomatic region. *P. satpuraensis* is distinguished from *P. sherensis* and *P. marwarensis* by the occurrence of isolated stomata in the apical half of the lower surface of its leaves. *P. rewaensis* Bose & Sukh-Dev (1971) has a similar stomatal distribution but is quite distinct morphologically in having comparatively larger and narrower leaves.

Holotype — Specimen no. B.S.I.P. 435/926.

Type Locality — Sehora, on the Sher River, District, Narsinghpur, Madhya Pradesh.

Horizon & Age — Jabalpur Group, ?Upper Jurassic.

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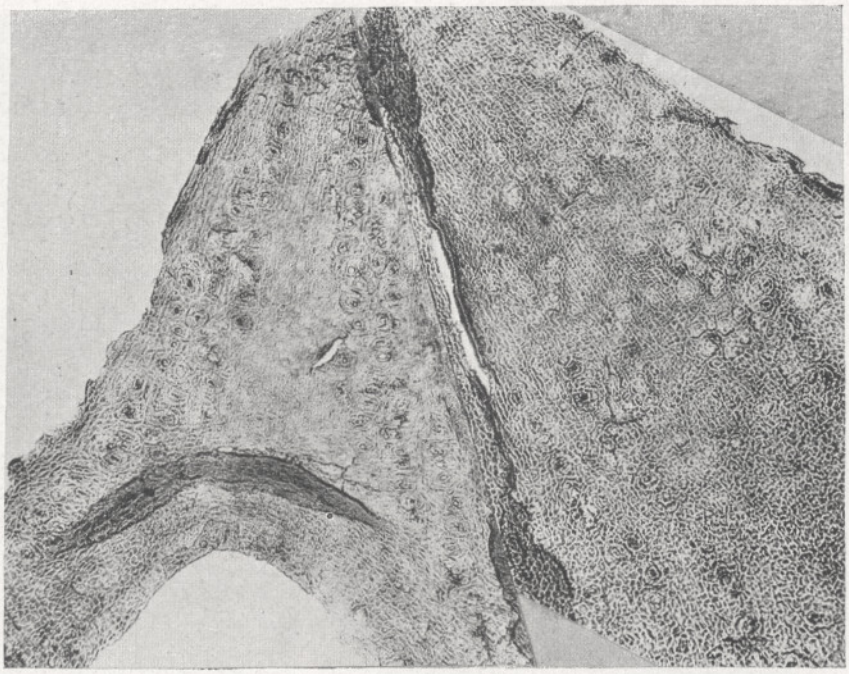

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EXPLANATION OF PLATES

PLATE 1

1. *Elatocladus pseudotenerrima* sp. nov.: a sterile twig. Specimen no. B.S.I.P. 124/926. × nat. size (Holotype).
2. *E. pseudotenerrima*: another sterile shoot. Specimen no. B.S.I.P. 248/926. × nat. size.
3. *E. pseudotenerrima*: stomatic cuticle from specimen in fig. 1. Slide no. B.S.I.P. 124/926-1. × 150.
4. *Elatocladus sehoraensis* sp. nov.: cuticle showing stomata, from specimen in fig. 5. Slide no. B.S.I.P. 53/926-1. × 150.
5. *E. sehoraensis*: a sterile twig. Specimen no. B.S.I.P. 53/926. × nat. size (Holotype).
6. *Elatocladus bosei* sp. nov.: sterile twig. Specimen no. B.S.I.P. 28943/331A. nat. size (Holotype).
7. *E. bosei*: showing distribution and orientation of stomata. Slide no. B.S.I.P. 28943/331A-1. × 150.

PLATE 2

8. *Pagiophyllum sherensis* sp. nov.: sterile twig. Specimen no. B.S.I.P. 33883. × nat. size. (Holotype).
9. *P. sherensis*: upper cuticle from specimen in fig. 8. Slide no. B.S.I.P. 33883-1. × 40.
10. *P. sherensis*: lower cuticle from specimen in fig. 8. Slide no. B.S.I.P. 33883-1. × 40.
11. *P. sherensis*: stomata from the upper cuticle enlarged. Slide no. B.S.I.P. 33884-2. × 150.
12. *Pagiophyllum satpuraensis* sp. nov.: sterile twig. Specimen no. B.S.I.P. 435/926. × nat. size (Holotype).
13. *P. satpuraensis*: stomata from the upper cuticle enlarged. Slide no. B.S.I.P. 435/926-3. × 150.