

# THREE NEW SPECIES OF *PAGIOPHYLLUM* FROM BANSA, MADHYA PRADESH, INDIA

M. N. BOSE AND SUKH-DEV

*Birbal Sahni Institute of Palaeobotany, Lucknow*

## ABSTRACT

Three new species of *Pagiophyllum*, viz., *P. bansaensis*, *P. marwarensis* and *P. rewaensis*, based on cuticular features, are described here from Bansa.

## INTRODUCTION

The Lower Cretaceous beds at Bansa, Shahdol district, Madhya Pradesh are fairly rich in fossil conifers. Out of the conifers, recently collected from there, we have recognized three new species of *Pagiophyllum*. The cuticular features of all these species have been described in detail. Under one of the new species, viz. *P. marwarensis*, the original specimens of Sahni (1928, pl. 3, figs. 32, 33) described as *Pagiophyllum* cf. *peregrinum* (L. & H.) from Bansa, have been included.

## DESCRIPTION

GENUS ***Pagiophyllum*** Heer

***Pagiophyllum bansaensis*** n.sp.

Pl. 2, figs. 10, 12; Text-fig. IA-D

*Diagnosis*—Twig more or less straight, about 7 mm in breadth. Leaves spirally borne, directed forward or slightly spreading laterally, falcate or sometimes apex slightly bent upwards, ovate to lanceolate, keeled, arising from a rhomboidal leaf base cushion, bases slightly decurrent but concealed, apex acute, typically  $5 \times 2.5$  mm (range noted  $3.5-5 \times 2.5$  mm). Margin entire.

Leaves amphistomatic. Cuticle of equal thickness on both sides, about  $6 \mu$ . Lower side with more stomata than the upper. Upper side showing a few stomata arranged in two triangular areas, which seem to join near the apex. Within triangular areas stomata placed in ill-defined single files. Individual stomata slightly sunken, mostly placed distantly, a few touching each other. Epidermal cells rectangular or polygonal. Lateral and end-walls almost straight,  $3-6 \mu$  thick, surface smooth. Epidermal cells near margin and between stomatal files polygonal or rectangular, but much longer than broad. On lower surface stomata not so regularly arranged, distributed over entire surface, sometimes a few stomata tending to form discontinuous single files. Individual stomata sunken, broadly oval, placed longitudinally or rarely slightly oblique. Subsidiary cells 4-5, rarely 6, slightly more cutinized than ordinary epidermal cells, forming an oval, polygonal or dumbbell-shaped pit. Guard cells

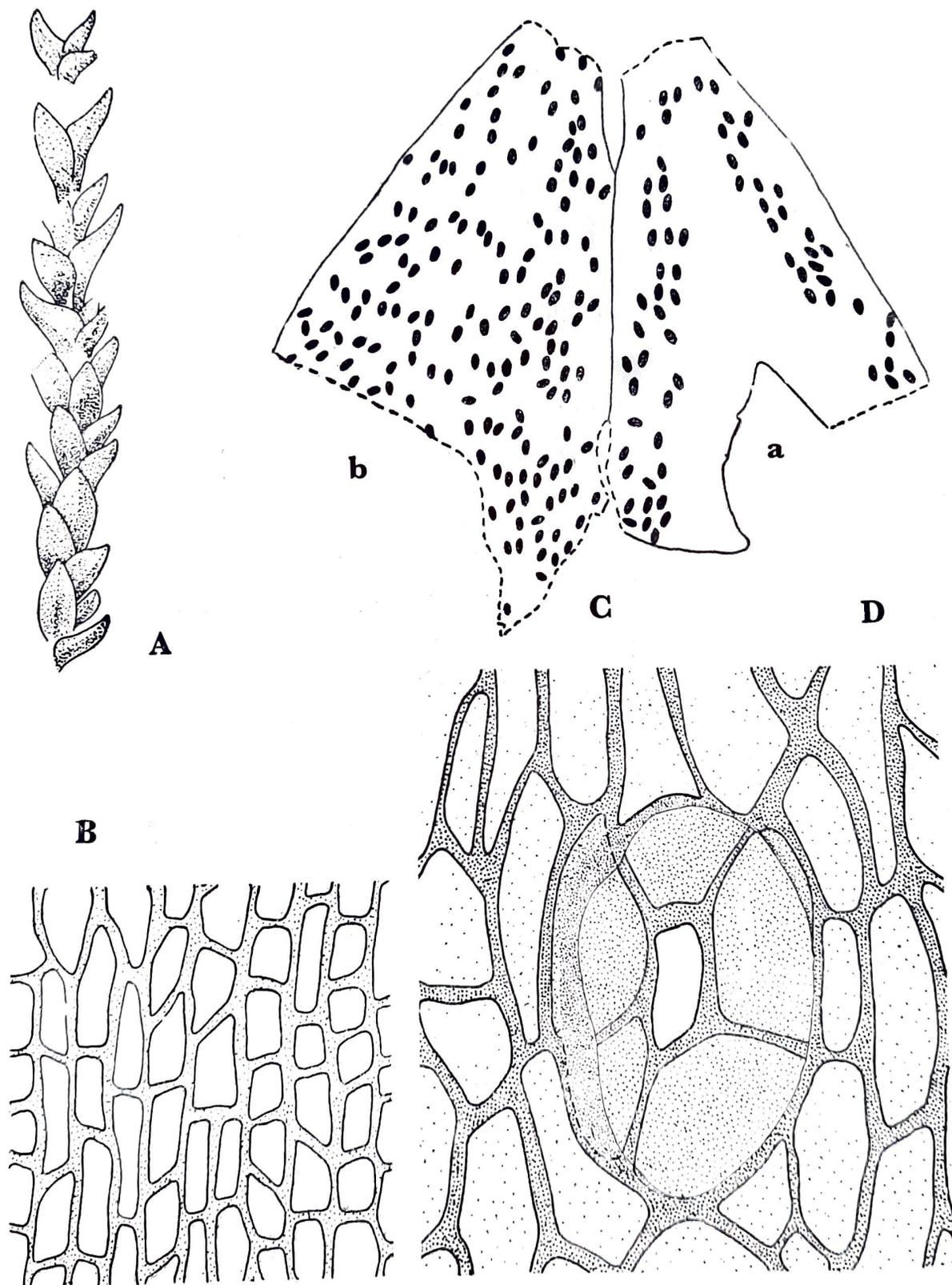
sunken, very thinly cutinized, mostly not preserved. Each stoma accompanied by a ring of encircling cells. Encircling cells narrower than ordinary epidermal cells.

*Holotype*—No. 30658 of the Birbal Sahni Institute of Palaeobotany.

*Locality*—About 2 Km,—N.N.W. of Bansa.

*Horizon and Age*—Jabalpur Series, Lower Cretaceous.

*Comparison*—*Pagiophyllum bansaensis* resembles *P. rewaensis* in the distribution of stomata on the upper side. In both, stomata are confined to two triangular areas closer



Text-fig. 1. *Pagiophyllum bansaensis* n. sp.: A, specimen no. 30658, x 2. B, cells of the lower cuticle, sl. no. 4308, x 250. C, showing orientation and distribution of stomata; a—upper cuticle, b—lower cuticle, sl. no. 4308, x 10. D, stoma and epidermal cells, sl. no. 4308, x 500.

to the margin. But in the former the upper side has only a few stomata as compared to the latter where the upper side has much more stomata. In *P. bansaensis* the lower side has large number of stomata scattered irregularly almost over the entire surface. But in *P. rewaensis* the lower side has only a few stomata near the base and apex. The stomatal apparatus in these two species shows some apparent resemblances; in both, stomata are longitudinally orientated, sunken and subsidiary cells are 4-6. But in *P. bansaensis* stomata are more sunken and the subsidiary cells are 4 or 5 (rarely 6), whereas, in *P. rewaensis* subsidiary cells are mostly 4 or 6. Moreover, in external form the leaves of *P. rewaensis* are larger and more spreading. The present species resembles *P. veronense* Wesley (1956) in general form of the leaves and in the occurrence of stomata on both the sides. But in *P. veronense* the stomata are arranged in longitudinal rows on both the surfaces, whereas, they are more or less in two triangular areas on the upper side and irregularly scattered on the lower side in *P. bansaensis*. The anticlinal walls of the epidermal cells are broken by numerous pits in *P. veronense*, while this feature is lacking in *P. bansaensis*. *P. rotzoanum* (Messalongo) Wesley (1956) may also be compared with the present species because of the presence of stomata on both the sides. But in *P. rotzoanum* they are again arranged in longitudinal rows. Besides, the characteristic short hollow chimney formed by the thickening of the subsidiary cells in *P. rotzoanum* is lacking in *P. bansaensis*.

***Pagiophyllum marwarensis* n. sp.**

Pl. 1, figs. 1-5; Pl. 2, figs. 11, 13; Text-fig. 2A-D

1882 *Pachyphyllum peregrinum* Schimp.; Feistmantel, pl. 3, figs. 4, 8, 16.

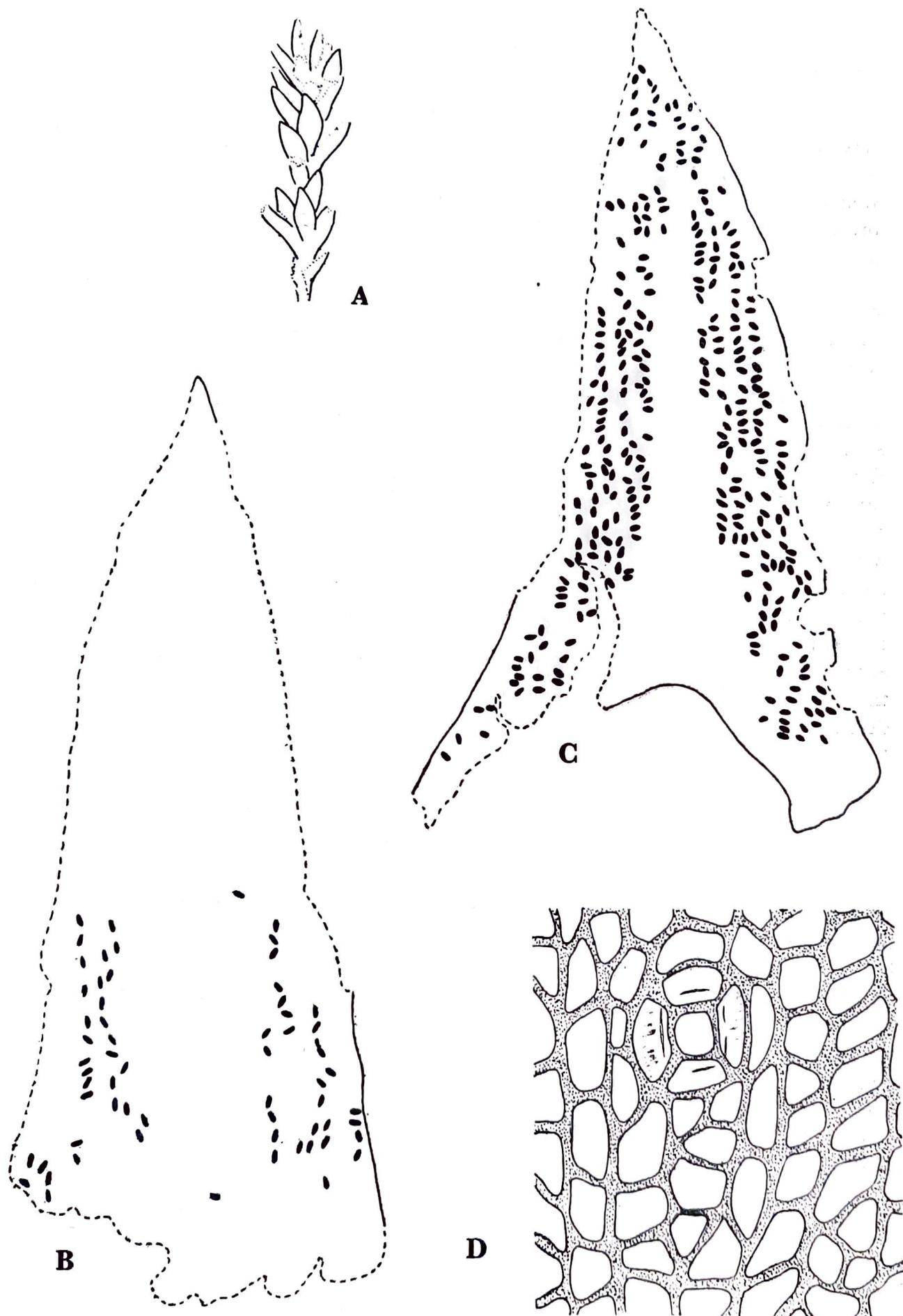
1920 *Pagiophyllum* sp. cf. *P. peregrinum* Schimp.; Seward and Sahni, p. 35.

1928 *Pagiophyllum* cf. *peregrinum* (L. & H.); Sahni, pl. 3, figs. 32, 33.

*Diagnosis*—Straight or considerably bent twigs, about 1.6. cm broad, unbranched. Leaves spirally borne, arising from a rhomboidal leaf base cushion, directed side-ways or forwards, lanceolate, typically measuring 7 × 3 mm (range 4-8 × 1.5-3 mm), keeled, base broad, apex acute, margin entire.

Leaves amphistomatic. Cuticle about 7.6 μ thick on both sides. Stomata more on upper than lower side. On lower side stomata sparse, arranged in ill-defined single files. These stomatal files usually become evanescent after about 2/3 length. Individual stomata sunken, transversely, obliquely or longitudinally orientated. Ordinary epidermal cells polygonal, lateral and end-walls almost straight and 3-12 μ thick. Surface not specialized. On upper surface stomata arranged in two triangular areas leaving a broad central astomatic region, but near apex stomata present in the central region also, thus the two triangular areas converge and join near the apex. Inside the triangular areas stomata usually arranged in single files, occasionally a few stomata lying outside files. Files discontinuous from base to apex, breaking and forming new files. Each file separated by 2-3 ordinary epidermal rows of cells. Stomatal files not sunken but individual stomata sunken. Arrangement of stomata inside each file same as on lower side. Stomata consisting 4-6 (mostly 4 or 5) subsidiary cells. Subsidiary cells slightly more cutinized than ordinary epidermal cells. Guard cells thinly cutinized, having a slit-like opening and not sunken. Mostly with a ring of encircling cells. Epidermal cells polygonal, fairly big near the base and in the central region. Inside the triangular areas and between the files they are more elongate. Some of the epidermal cells and the subsidiary cells finely striated.

*Holotype*—No. 30310 of the Birbal Sahni Institute of Palaeobotany.



Text-fig. 2. *Pagiophyllum marwarensis* n. sp.: A, specimen no. 30134, x 2, (specimen consumed). B, lower cuticle, showing orientation and distribution of stomata, sl. no. 4304, x 20. C, upper cuticle, showing orientation and distribution of stomata, sl. no. 4303, x 20. D, lower cuticle, sl. no. 4305, x 250.

*Locality*—Marwar Ghat about  $\frac{3}{4}$  Km, N.E. and about  $\frac{1}{2}$  Km and  $\frac{3}{4}$  Km, N.N.W. of Bansa.

*Horizon and Age*—Jabalpur Series; Lower Cretaceous.

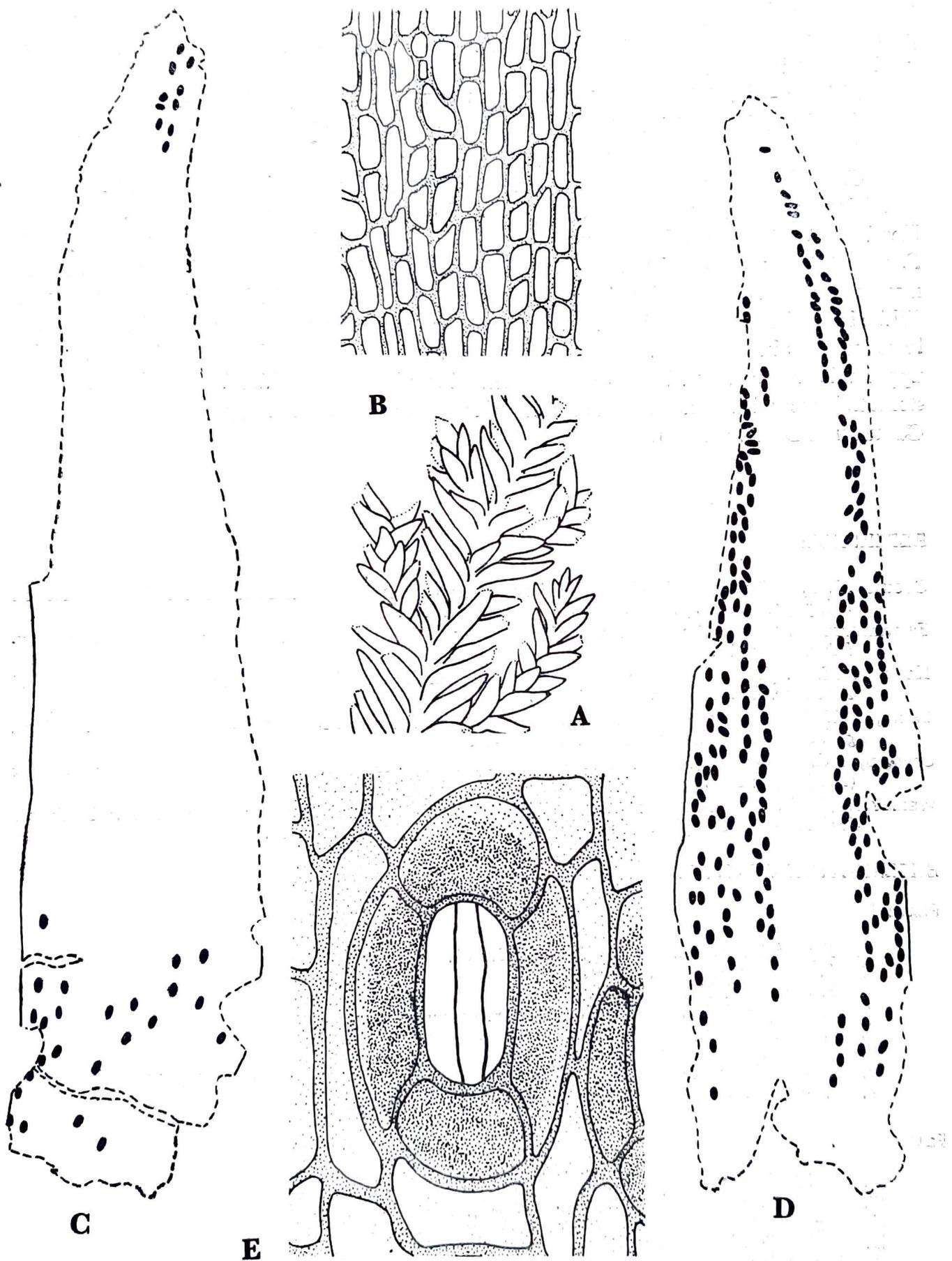
*Comparison*—In the arrangement and distribution of stomata *P. marwarensis* comes nearest to *P. rewaensis*. In both species the upper surface has more stomata which are arranged in two triangular areas leaving a central astomatic region. But in the former the stomata are mostly transversely orientated, whereas, in the latter they are longitudinally orientated. On the lower surface in *P. rewaensis* stomata are irregularly distributed near apex and base, but in *P. marwarensis* they are confined to the base only in irregular files. In *P. marwarensis* the stomatal apparatus is more or less circular, whereas, in *P. rewaensis* it is oval. In general form of the leaves and in the nature of epidermal cells and stomata *P. marwarensis* resembles *P. peregrinum* (L. & H.) Schenk. In both stomata are arranged in single files and within the files they are mostly transversely orientated. Both the species have striations on the cell walls and they have stomata with 4-6 subsidiary cells. But the two differ from each other in the nature of stomatal distribution. In *P. marwarensis* the upper side has more stomata, but in *P. peregrinum* (L. & H.) Schenk, it is just the reverse. *P. peregrinum* (L. & H.) described by SAHNI (1928, pl. 3, figs. 43-47) from Sher river (Satpura basin) has small and less spreading leaves than *P. marwarensis*. Sahni could not get bigger pieces of cuticle in order to show the distribution of stomata; he thought them to be arranged in bands and obliquely and longitudinally orientated. From the new preparations, made out by one of us (Bose) from Sahni's figured specimen no. 4/898 (1928, Pl. 3, fig. 43), we found the stomata to be present only on one side and they are irregularly distributed lying close (Pl. 2, figs. 14, 15) to each other, the subsidiary cells numbering 4-9, surface of subsidiary cells not striated. Also the surface wall of ordinary epidermal cells is without striations. Thus it is obvious that Sahni's specimen is quite different from *P. marwarensis* and we also think the specimens described as *P. peregrinum* (L. & H.) by Sahni is different from the specimens of *P. peregrinum* (L. & H.) Schenk described by KENDALL (1948).

***Pagiophyllum rewaensis* n.sp.**

Pl. 1, figs. 6, 7, 8; Pl. 2, fig. 9; Text-fig. 3A-E

*Diagnosis*—Branched twigs, about 1.7 cm broad. Branchlets borne laterally in the same? plane. Leaves crowded, spirally arranged, directed forwards, lanceolate, typically  $9 \times 2$  mm (range noted  $2.5 \times 1.5$ - $10 \times 2$  mm), broad at base and narrowing rather abruptly, slightly falcate, lower surface keeled, bases decurrent and concealed by the lower leaves, apex acute, margin entire.

Cuticle of equal thickness on both sides (about  $2.5 \mu$  thick). On lower side stomata few, irregularly scattered, sometimes seem to form single rows, longitudinally placed near base and a few near apex. On upper surface stomata arranged in rows forming two long, narrow triangular areas. Both the triangular areas lying near margins, leaving a fairly broad central astomatic region. Inside each triangular area stomata arranged in single rows, each row separated usually by 2-4 cells. Stomata slightly sunken, longitudinally or, sometimes slightly obliquely placed, mostly distant, rarely lying close to each other, but two stomata never sharing common subsidiary cell. Stomata on both sides mostly oval,  $56$ - $110 \times 47$ - $48 \mu$  in size. Subsidiary cells 4 or 6 ( $2+2$  or  $2+4$ ), slightly more cutinized than ordinary epidermal cells, forming an oval pit. Guard cells fairly well cutinized, sunken. Aperture narrow and slit-like. A ring of encircling cells present, but not specialized. Epidermal cells of the non-stomatic region of lower and upper sides rectangular and serially arranged,  $31$ - $62 \times 12$ - $13 \mu$ .



Text-fig. 3. *Pagiophyllum rewaensis* n. sp.: A, specimen no. 30231 A, x 2. B, upper cuticle, sl. no. 4307 x 250. C, lower cuticle, showing orientation and distribution of stomata, sl. no. 4306, x 20. D, upper cuticle, showing orientation and distribution of stomata, sl. no. 4306, x 20. E, two stomata and epidermal cells, sl. no. 4306, x 500.

Lateral and end-walls straight and fairly thick (1.5-6 $\mu$ ), rarely wavy. Epidermal cells between stomata of each row polygonal and usually broader than long, those between rows either polygonal or rectangular, longer than broad and serially arranged. Surface wall without any papillae or trichomes.

*Holotype*—No. 30231-A of the Birbal Sahni Institute of Palaeobotany.

*Locality*—Marwar Ghat about 2 Km N.E. and about 1 $\frac{1}{2}$  Km, N.N.W. of Bansa.

*Horizon and Age*—Jabalpur Series; Lower Cretaceous.

*Comparison*—The majority of species of *Pagiophyllum* described by KENDALL (1948) and WESLEY (1956) such as *P. insigne* Kendall, *P. connivens* Kendall, *P. ordinatum* Kendall, *P. rotzoanum* (Messalongo) Wesley, *P. veronense* Wesley, *P. valdassense* Wesley and *P. magnipapillare* Wesley, have stomata on both the surfaces. From all these species *P. rewaensis* can readily be distinguished by the arrangement and distribution of the stomata. While in all the above mentioned species stomata are distributed over most of the upper and lower surfaces in rows, in *P. rewaensis* the stomata are very few on the lower side and on the upper side are arranged in two well-defined triangular areas. This kind of distribution of stomata is met with in some of the species of recent *Araucaria* belonging to sect. *Eutacta* (see COOKSON & DUGAN, 1951).

## REFERENCES

- COOKSON, I. C. & DUGAN, S. L. (1951). Tertiary Araucariaceae from South-Eastern Australia with notes on living species. *Aust. J. scient. Res. Ser. B.*, **4**(4): 415-449.
- FEISTMANTEL, O. (1882). The fossil flora of the South Rewa Gondwana basin. *Mem. geol. Surv. India. Palaeont. indica.* **4**(1):1-52.
- KENDALL, M. W. (1948). On six species of *Pagiophyllum* from the Jurassic of Yorkshire and Southern England *Ann. Mag. Nat. Hist. Ser. 12*, **1**: 73-108.
- SAHNI, B. (1928). Revisions of Indian fossil plants: part 1-Coniferales (*a. Impressions and Incrustations*). *Mem. geol. Surv. India, Palaeont. indica* (N.S.), **11**: 1-49.
- SEWARD, A. C. & SAHNI, B. (1920). Indian Gondwana Plants: A Revision. *Mem. geol. Surv. India, Palaeont. indica* (N.S.), **7**(1): 1-41.
- WESLEY, A. (1956). Contributions to the knowledge of the flora of the grey limestones of Veneto: Part I. *Memorie Degli Istituti di Geologia E Mineralogia Dell' Universita di Padova.* **19**: 1-68.

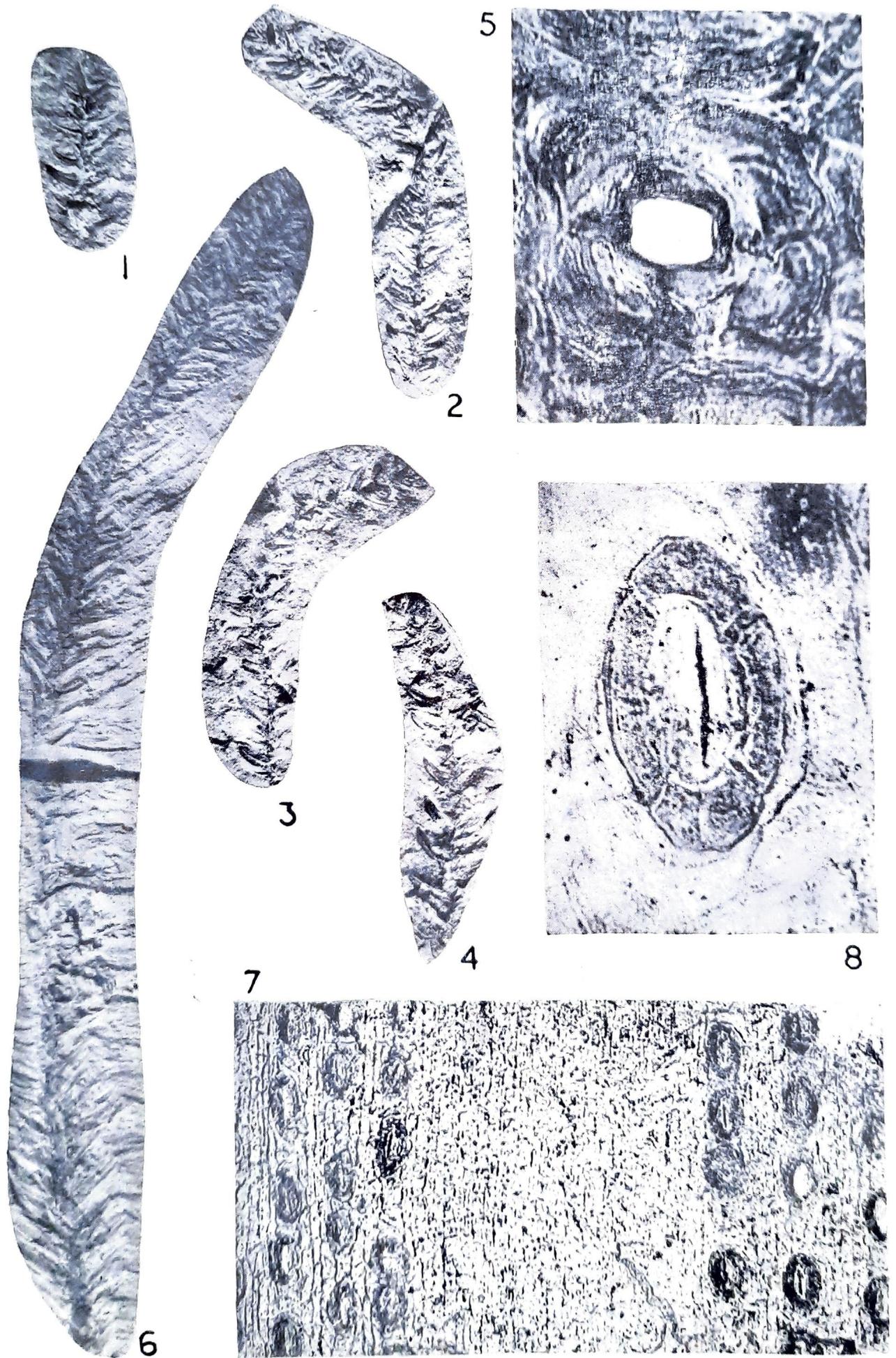
## EXPLANATION OF PLATES

### PLATE 1

1. *Pagiophyllum marwarensis* n. sp. No. 35001.  $\times 1$ .
2. *P. marwarensis* No. 30310.  $\times 1$ .
3. *P. marwarensis* No. 30310.  $\times 1$ .
4. *P. marwarensis* No. 65/470.  $\times 1$ . (specimen consumed).
5. *P. marwarensis*, a single stoma magnified. Sl. No. 4305.  $\times 500$ .
6. *Pagiophyllum rewaensis* n.sp. No. 30231 A.  $\times 1$ .
7. *P. rewaensis*, upper cuticle, showing stomatal bands on both the margins. Sl. No. 4306.  $\times 80$ .
8. *P. rewaensis*, a single stoma magnified, Sl. No. 4306.  $\times 500$ .

### PLATE 2

9. *Pagiophyllum rewaensis* n. sp. No. 30231-B.  $\times 1$ .
10. *Pagiophyllum bansaensis* n. sp. No. 30658.  $\times 1$ .
11. *Pagiophyllum marwarensis* n. sp. No. 35002.  $\times 1$ .
12. *Pagiophyllum bansaensis*, a single stoma magnified. Sl. No. 4308.  $\times 500$ .
13. *Pagiophyllum marwarensis*, upper cuticle, showing stomata. Sl. No. 4305.  $\times 150$ .
14. *Pagiophyllum peregrinum* (L. & H.), showing distribution of stomata. Sl. No. 4/898.  $\times 150$ .
15. *P. peregrinum*, a single stoma magnified. Sl. No. 4/898.  $\times 500$ .





9



10



11

14



13

12

15

