SOME DETACHED SEED-SCALES BELONGING TO ARAUCARIACEAE FROM THE MESOZOIC ROCKS OF INDIA

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ABSTRACT

Taxonomy of some detached seed-scales, of Mesozoic Araucariaceae, earlier referred to *Araucarites cutchensis*, has been revised. Non-ligulate forms have been placed in the genus *Araucarites* while the ligulate types have been referred under the extant genus *Araucaria*. The name *Araucarites cutchensis* is conserved for impression forms only. Two new species of *Araucarites* (viz., *A. sehorænsis* and *A. minutus*) and a new species of *Araucaria* (viz., *A. pantiana*) have been described, on the basis of the cuticular features of the seed-scales.

INTRODUCTION

In India araucarian seed-scales were first described by FEISTMANTEL (1876) from Kutch as *Araucarites cutchensis*. Later some more specimens, belonging to the same species, were described by FEISTMANTEL (1877, 1879 and 1882) from Sher River, Jabalpur, Vemavaram and Sriperumbudur. Some of these were re-examined and figured by SEWARD and SAHNI (1920) and SAHNI (1928). Recently, PANT and SRIVASTAVA (1968) studied all the previously described specimens of *A. cutchensis* along with a few specimens collected by them from Bansa, South Rewa Gondwana Basin. They were successful in getting cuticular preparations out of a few specimens collected by them from Bansa. The cuticle of these specimens was compared with those of the seed-scales of *Araucaria columnaris* (Foster) Hooker. On the basis of this study they transferred all the previously described specimens of *Araucarites cutchensis* under the extant genus *Araucaria* and described them as *Araucaria cutchensis* (Feistmantel). For the lectotype they selected the specimen (G.S.I. no. 366/16) figured by SAHNI (1928, pl. 5, fig. 65) and not a specimen out of the original collection described by FEISTMANTEL (1876) from Kutch. The lectotype differs from the Kutch specimens (FEISTMANTEL, 1876, pl. 7, fig. 7; pl. 8, figs. 2-6; pl. 9, figs. 1-3 and pl. 12, fig. 10) in having a prolonged narrow tip. The Kutch specimens have short and bluntly pointed tip. Pant and Srivastava had also noticed this difference but they preferred to place both the types under the same species because they found intermediate forms.

During the last few years we have collected new specimens from Manzal and Kakadbhit in Kutch, Songad in Kathiawar, Sher River near Sehora and Bansa in South Rewa Gondwana Basin. None of the Kutch specimens showed the prolonged tip, while most of the specimens from Bansa were having prolonged narrow tip. The specimens from Sher River near Sehora were of three types in external appearance. Some of the Sehora specimens were with prolonged narrow tip (Pl. 1, Fig. 17), a few resembled more the Kutch specimens in having short bluntly pointed tip (Pl. 1, Figs. 6-9). In addition to these two types there were some which were smaller in size (Pl. 1, Figs. 10-15) than the Kutch specimens and they had short pointed tip. The cuticles in these three types were also found to be different from each other. Only the specimens with prolonged tip (Pl. 1, Figs. 16, 17) resembled in cuticular structure *Araucaria cutchensis* (Feistmantel) Pant & Srivastava. Now

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the question naturally arises as to which one of these three types with different cuticular features is *Araucarites cutchensis*. From external features it is more likely that the specimens with short apices are more closer to the original specimens described by FEISTMANTEL (1876) from Kutch. But in the absence of cuticle in the Kutch specimens we, at present, prefer to keep the Sehora specimens (Pl. 1, Figs. 6-9) separate from *Araucarites cutchensis* and preserve the original name of FEISTMANTEL (1876) for the impressions only. Unlike some of the specimens from Bansa, in none of the Kutch specimens ligule is preserved. Ligule is also not visible in any of the specimens, with short tip from Sher River. Here the non-ligulate types have been described under the genus *Araucarites*, whereas, the ones with ligule under *Araucaria*.

DESCRIPTION

Araucarites cutchensis Feistmantel 1876

Pl. 1, Figs. 1-5; Text-figs. 1A-E

1876 *Araucarites cutchensis* Feistmantel, p. 62, pl. 7, fig. 7; pl. 8, figs. 2-6; pl. 9, figs. 1-3; pl. 12, fig. 10.

1877 *Araucarites cutchensis* Feistm. : Feistmantel, p. 16 (*partim*), pl. 4, fig. 4 (only the specimen figured on the upper left hand side and not the Desmiophyllums); pl. 10, figs. 2, 3, 5-7, 10-12, 14-16 (in fig. 16 only the specimen figured on the right hand side).

1879 *Araucarites cutchensis* Fstm. : Feistmantel, p. 27 (*partim*), pl. 14, fig. 6, 9; pl. 15, fig. 1; pl. 16, fig. 15.

1882 *Araucarites cutchensis* Fstm. : Feistmantel, p. 44 (*partim*), pl. 3, fig. 12, 19.

1919 *Araucarites cutchensis* Feist. : Seward, p. 264.

1920 *Araucarites cutchensis* Feist. : Seward & Sahni, p. 34, pl. 6, figs. 63, 64.

1928 *Araucarites cutchensis* Fst. : Sahni, p. 31.

1932 *Araucarites macropterus* (Feist): Deb, p. 103, fig. 3.

1967 *Araucarites cutchensis* Feistm. : Ramanujam, p. 87, figs. 2, 3.

1959 *Araucarites cutchensis* Feistm. : Pascoe, p. 991, 994, pl. Jabalpur and Umia floras, fig. 13.

1963 *Araucarites cutchensis* Feistmantel : Sitholey, p. 48, pl. 14, fig. 100.

1963 *Araucarites* sp. : Adyalkar & Rao, p. 319, pl. 38, fig. 4.

1968 *Araucarites cutchensis* Feistm.: Baksi, p. 210, pl. 3, fig. A-B.

Emended diagnosis—Detached seed-scales, 1.5 to 3.5 cm long and 1.4 to 2.8 cm wide, more or less wedge-shaped with curved distal margins or sloping sides. Base of seed-scale narrow, truncate; tip short, bluntly pointed or acute, measuring 3-8 mm in length and 2-4 mm in width at broadest point. Main body of seed-scale on dorsal side finely striated in longitudinal direction; on ventral side having medianly placed obovate seed (in compressed state). Seed possibly embedded, 1.1 to 2 cm long and 0.5 to 0.9 cm wide at broadest point, surface often showing longitudinal striations. Ligule absent.

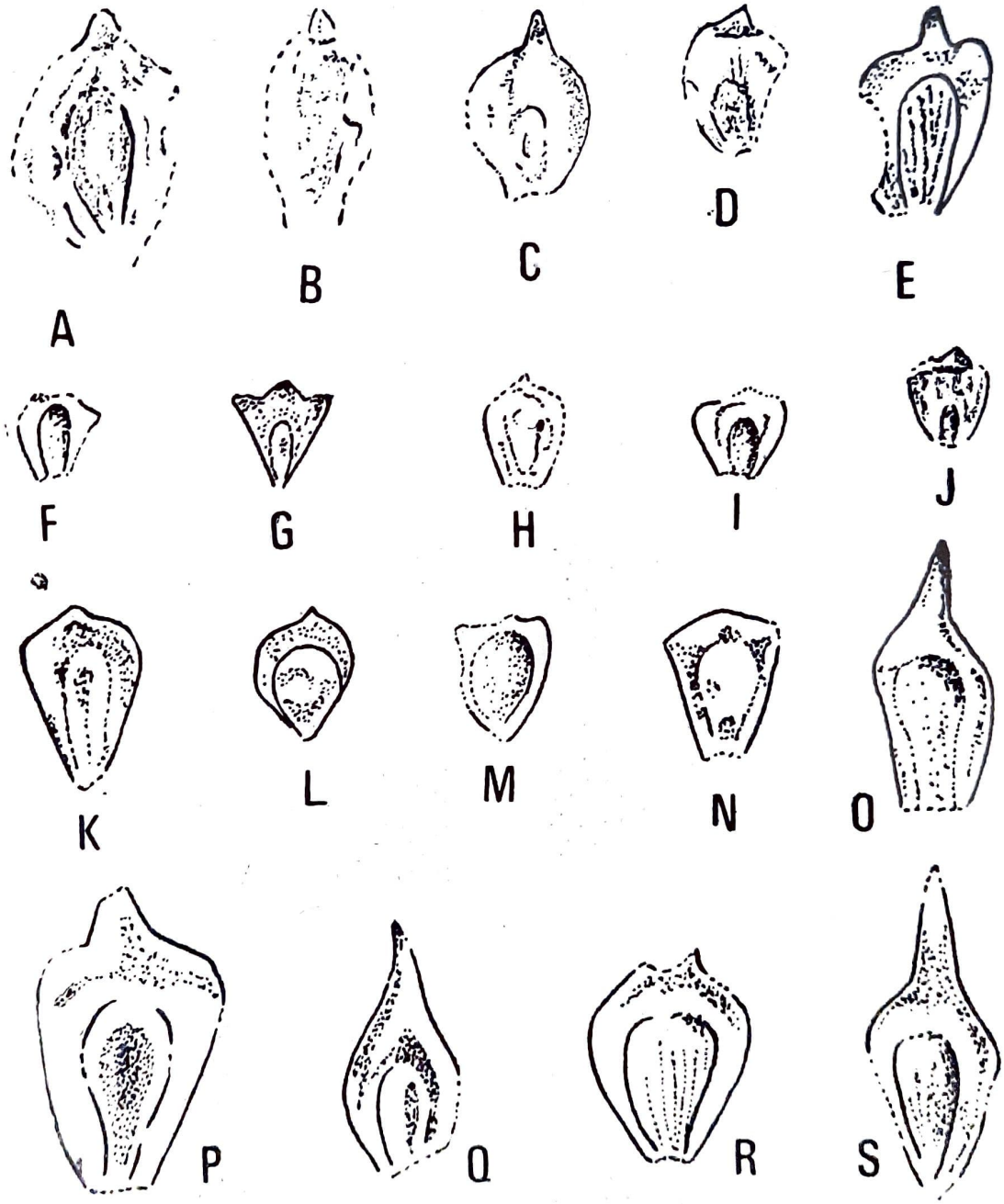
Lectotype—No. 4848, the Geological Survey of India, Calcutta.

Locality—Type locality: Kakadbhit, Kutch; *Other localities:* Songad in Kathiawar, Himmatnagar, Sher River near Sohora, Jabalpur, Onthea and Mirzachowki in the Rajmahal Hills, Vemavaram, Deronadula in the Nellore-Kistna District and Naogaon, west of Maleri.

Age—Kakadbhit (? Upper Jurassic); other localities (Upper Jurassic—Lower Cretaceous).

Description—All the specimens from Kutch range in size from 2.3-2.5 × 1.5-1.8 cm and have short bluntly pointed tip. The specimens from the Rajmahal Hills, described by RAMANUJAM (1957, figs. 2,3), look more like the Kutch specimens but are slightly bigger in size. In this respect the Songad specimens (Pl. 1, Fig. 5) are closer to the Rajmahal specimens. However, the seed-scales from Songad have slightly longer and more pointed tip than the specimens from the Rajmahal Hills and Kutch. The seed-scales from Vemavaram too have longer and pointed tips like the Songad specimens. But the Vemavaram specimens are smaller in size than the Songad specimens. They are even smaller than some of the Kutch specimens.

Comparison—HALLE (1913) figured a few specimens of *Araucarites cutchensis* from Graham Land. The specimens from Graham Land show a wide range in size and shape. Out of these, the specimen figured in pl. 8, fig. 7 somewhat resembles the specimens of *A. cutchensis* collected from Songad (Pl. 1, Fig. 5). Songad specimens are, however, slightly

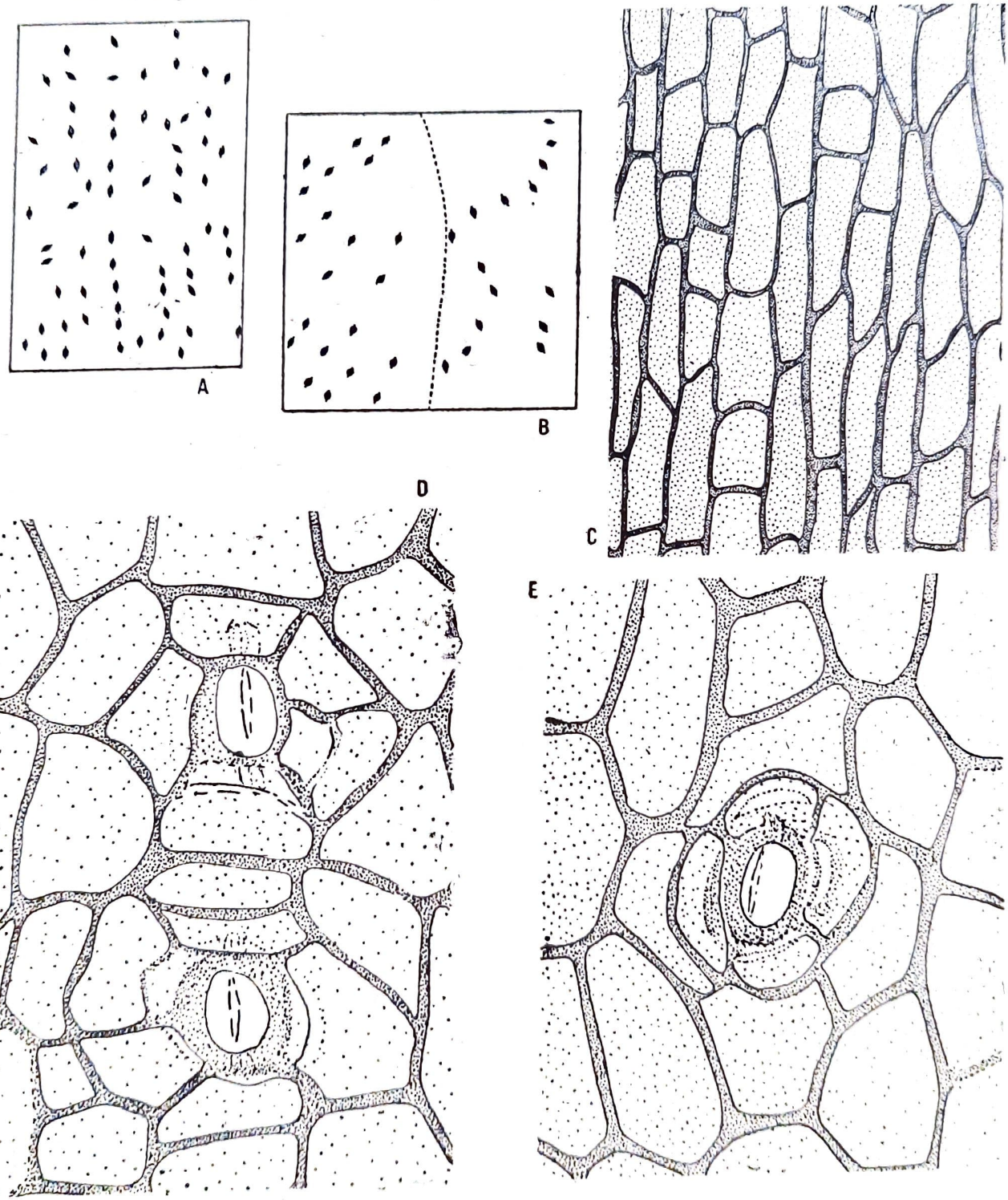


Text-fig. 1. A-E, *Araucarites cutchensis* Feistmantel, A-D (G.S.I. nos. 4848, 4818, 4735 and 4815), E (B.S.I.P. no. 35070); F-J, *Araucarites minutus* sp. nov., F-I (B.S.I.P. nos. 35075, 35074, 35076 and 35072B), J (G.S.I. no. 4737); K-N, *Araucarites sehoraensis* sp. nov. (B.S.I.P. nos. 35073, 35072A, 35072D and 35071); O-S, *Araucaria pantiana* sp. nov., O, Q, S (G.S.I. no. 4868, 4961 and 4958), P, R, (B.S.I.P. nos. 33864 and 33841). × 1.

bigger in size than the Graham Land specimens. *A. cutchensis* described by ARBER (1917) from Mount Potts, Canterbury and Mokoia, Southland in New Zealand differs from the Indian specimens in having broad, rounded, or truncated apex. *A. cutchensis* from Patagonia described by BERRY (1924, fig. 2) resembles more the specimen from Kutch in size and shape. Out of the specimens of *A. milleri* Seward (1911) from Sutherland, the specimen figured in pl. 5, fig. 97 may be compared with the specimens from India. This specimen is, however, incomplete on distal side.

Araucarites sehoraensis sp. nov.

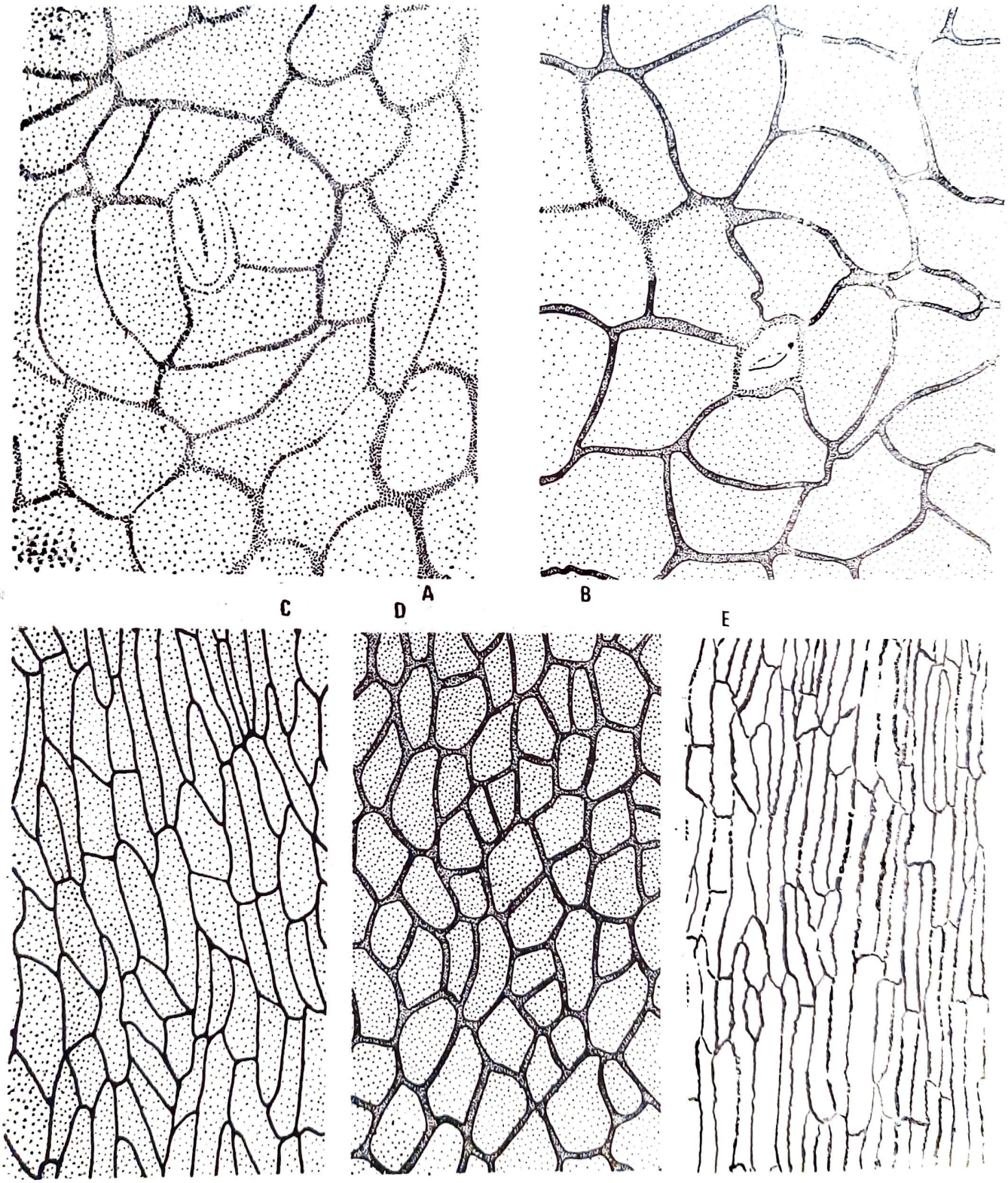
Pl. 1, Figs. 6-9, 18-19; Text-figs. 1 K-N, 3A, C, D



Text-fig. 2. A, *Araucaria pantiana* sp. nov., showing distribution of stomata, slide no. 33864-1, × 25; B, *Araucarites minutus* sp. nov., showing distribution of stomata, near extreme tip, slide no. 35072B-1, ×25; C, *Araucaria pantiana*, showing a few cells from over seed, slide no. 33841-2, ×150; D, E, *A. pantiana*, showing stomata, slide no. 33864-1 and 30100-1, ×450.

Diagnosis—Seed-scales detached, more or less broadly wedge-shaped, measuring about 1.3 to 2 cm in length and 1.1 to 1.3 cm wide at broadest point. Seed-scale with narrow, truncate base, convex or straight shoulders, producing a median bluntly pointed acumen, in some distal side convex without any tip. Single obovate (in compressed state) immersed in scale, about 1 to 1.2 cm in length and 0.6 to 0.9 cm in maximum width, surface often showing fine longitudinal striations. Ligule absent.

Cuticle of seed-scale thin, amphistomatic; stomata few, mostly confined to distal end. Cells near base and along 'wing' mostly polygonal, some rectangular, fairly broad,



Text-fig. 3. A, *Araucarites sehoraensis* sp. nov., showing a stoma, slide no. 35072D-2, × 450; B, *Araucarites minutus* sp. nov., showing a stoma, slide no. 29121-2, × 450; C, *Araucarites sehoraensis* sp. nov., showing cells from over seed, slide no. 35072D-3, × 150; D, *A. sehoraensis*, showing cells of cone-scale, slide no. 35072A-1, ×150; E, *A. minutus*, showing cells from over seed, slide no. 29121-1 ×150.

sometimes rounded at corners; lateral and end-walls thick, straight; surface unspecializd. Stomata near base and along 'wing' extremely rare, irregularly scattered; near distal end stomata arranged in rows, a few lying outside rows. Stomatal rows separated from each other by non-stomatic zones of 6-8 cells in width. Within rows stomata obliquely placed, widely spaced, slightly sunken. Subsidiary cells 4-7 in number, mostly 6 or 7; walls thick and straight, surface smooth. Guard cells thinly cutinized, sunken in broadly oval pit; aperture slit-like. Encircling cells like ordinary epidermal cells. Cells within stomatal rows polygonal, irregularly arranged; those outside the rows, polygonal or rectangular, more or less serially arranged. Cell walls thick, surface smooth.

Cells over seed polygonal, much longer than broad; lateral and end-walls straight or slightly wavy; surface smooth.

Holotype—No. 35072D Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality—Sher River, near Sehora, District Narsinghpur, Madhya Pradesh.

Age—? Upper Jurassic.

Comparison—*Araucarites sehoraensis* comes closest to *A. cutchensis* in overall shape and size. In the present species the tip is not so prominent as in the latter. In some of the specimens of *A. sehoraensis* the distal side is convex and is without any tip (Pl. 1, Figs. 6, 7, 9). In this respect these specimens resemble more *A. cutchensis* described by Arber (1917) from Mokoia, Gore, Southland. In general shape and size some of the secimens of *A. sehoraensis* (Pl. 1, Figs. 6, 7) are very similar to *Araucarites* sp. B described by Seward (1904) from Victoria, Australia. Like *A. sehoraensis*, the specimens of *A. sardinicus* (Krasser) described by Edwards (1929) are without any distinct tip. Unlike the present species the distal corners of *A. sardinicus* are slightly notched forming shoulders. *Araucarites* sp. reported by Herbst (1966) from Provincia de Neuquen, Argentina, too, are without any prominent tip.

Araucarites minutus sp. nov.

Pl. 1, Figs. 10-15; Pl. 2, Figs. 26-27; Text-fig. 1F-J, 2B, 3B, E

1879 *Araucarites cutchensis* Feistmantel, p. 27 (*partim*), pl. 14, figs. 7, 8.

1882 *Araucarites cutchensis* Fstm. : Feistmantel, p. 44 (*partim*), pl. 3, figs. 13-15.

1957 *Araucarites cutchensis* Feistm. : Ramanujam, p. 87, fig. 1.

Diagnosis—Detached seed-scales, about 1 to 1.5 cm long and 0.8 to 1.1 cm in maximum width, typically obcuneate, having a narrow truncate base; an expanded middle part with straight ascending sides, distal side at corners slightly raised; tip short, about 1 to 2 mm in height, acute. Single obovate (in compressed state) seed immersed in scale, about 0.8 to 1 cm long and 0.3 to 0.6 cm wide at broadest point, finely striated in longitudinal direction.

Cuticle of scale on both sides almost of similar thickness, amphistomatic, stomata confined towards distal end and tip; near base and along 'wing' extremely rare. Near tip and distal end stomata arranged in rows, rows sometimes discontinuous, a few stomata lying outside rows; within rows majority of stomata longitudinally placed, a few transverse or obliquely orientated. Subsidiary cells 4-5, mostly 5; lateral and end-walls thick, straight; surface smooth. Guard cells thinly cutinized, sunken in a pit; aperture narrow, slit-like. Encircling cells common, sometimes imperfectly dicyclic, like ordinary epidermal cells. Cells within stomatal rows rectangular or polygonal, longer side in transverse direction, irregularly arranged; lateral- and end-walls thick and straight; surface unspecialized. Each stomatal row separated by non-stomatal bands of about 2-4 cells (generally 3) in width.

Cells of non-stomatal bands mostly rectangular, sometimes polygonal, serially arranged; walls thick and prominent; surface smooth. Cells along 'wings' and near base like cells of non-stomatal bands.

Cells over seed, narrow, elongated, polygonal or rectangular; lateral- and end-walls straight or broken by pits; surface smooth.

Holotype—No. 29121, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality—Sher River, near Sehora, District Narsinghpur, Madhya Pradesh.

Age—? Upper Jurassic.

Comparison—In size and overall shape *Araucarites minutus* may be compared with *A. cutchensis* described by SEWARD (1922) from Tabbowa, Ceylon, *A. minimus* Archangelsky (1966) from the Ticó flora, Argentina and *A. falsani* Barale (1970) from the Upper Jurassic of Creys, France. *A. cutchensis* from Ceylon differs from the present species in having a longer tip and sloping shoulders. *A. minimus* has ligule and in the absence of details of the cuticular structure it is not possible to compare further with *A. minutus*. *A. falsani* has a longer tip than *A. minutus*, also in the former the distal ends have sloping shoulders and the regions of the 'wings' and seed show prominent longitudinal striations. In both, *A. minutus* and *A. falsani*, the subsidiary cells are mostly 5 in number but the majority of stomata in the latter species are obliquely or transversely placed.

Araucaria pantiana sp. nov.

Pl. 1, Figs. 16, 17; Pl . 2, Figs. 20-25; Text-figs. 1 0-S, 2A, C-E

1877 *Araucarites cutchensis* Feistmantel, p. 16 (*partim*), pl. 14, figs. 1, 4, 8, 9, 13.

1822 *Araucarites cutchensis* Fstm. : Feistmantel, p. 44 (*partim*), pl. 2, fig. 9, 11; pl. 12, fig. 5.

1928 *Araucarites cutchensis* Fst. : Sahni, p. 31, pl. 5, figs. 66, 67.

1968 *Araucaria cutchensis* (Feistmantel) Pant & Srivastava, p. 201, pl. 1, figs. 1-8, text-fig. IA-I.

1969 *Araucarites cutchensis* Feist. : Randhawa *et al.*, pl. 52, fig. 5.

Diagnosis (from PANT & SRIVASTAVA, 1968)—Detached seed-scales, 2.3-4 cm long and 0.9 to 1.5 cm wide at broadest point; typically showing a contracted base, an obcuneate middle part and a prolonged tip. Tip more or less caudate, showing a median ridge on ventral side, 1.5 to 2.5 cm long and 0.5 to 0.7 cm wide at broadest point beyond shoulders of scale. Middle part bearing a single medianly placed seed. Seed probably adnate, obovid, 0.7-1.7 cm long and 0.4 to 1 cm wide at broadest point, surface of seed often showing fine longitudinal striations. Scales often showing a triangular ligule, 4 mm long and 3 mm wide at broadest point, inserted between base of caudate tip and distal end of seed.

Cuticle of scale on both surfaces similar, tough, 3.5 μ to 4.5 μ thick over wings and up to 7 μ thick elsewhere. Stomata absent over seed (rarely a few may be present), wings and along median ridge of tip. Stomata confined mostly to distal part of scale beyond seed, amphistomatic but one surface of scale pauci-stomatic, with fewer stomata than an opposite multi-stomatic surface. Stomata on both surfaces tending to be arranged in single files, sometimes files discontinuous, occasionally a few stomata lying outside the files. Stomatal bands 1-3 cells apart, sometimes even more. Non-stomatiferous bands often appearing wider on pauci-stomatic surface due to presence of widely spaced alternating stomata in intervening bands. Within bands stomata longitudinally oriented, sometimes a few obliquely placed. Stomata commonly dicyclic. Subsidiary cells mostly 4 (2+2), sometimes 5,

rarely 6, partially overlapping guard cells, slightly less cutinized than ordinary epidemral cells. Encircling cells narrow often as wide as adjacent outer tangential wall of subsidiary cell. Guard cells sunken in a shallow pit, measuring 63 to 105 μ in length and 17 to 38 μ in breadth, peripheral outline of guard cells represented by a thickened rim along their (epidermal) dorsal wall, common wall of guard cells often obscure, guard cells usually showing hyaline areas at poles. Cells within stomatal bands less regularly arranged, polygonal, rectangular or rhomboidal, often wider than long, 35 to 45 μ long and 17 to 28 μ wide; lateral and end-walls straight; surface unspecialized. Cells along non-stomatiferous bands arranged in longitudinal rows, somewhat elongated, rectangular or polygonal, 31 to 67 μ long and 21 to 46 μ wide; walls like cells along stomatiferous bands. Cells towards boundary of seed, over 'wing' and in expanded proximal part of scale less regularly arranged, polygonal, rectangular or rhomboidal, often wider than long. Cells over 'wing' elongated 67 to 172 μ long and 17 to 52 μ wide, lateral and end-walls straight; surface smooth.

Cells over seed, elongated, polygonal; lateral and end-walls thick, straight; surface wall smooth.

Holotype—No. 20329, Prof. D. D. Pant collection, Botany Department, University of Allahabad, Allahabad.

Locality—Type locality: Bansa; *Other localities*: Chandia, Jabalpur and Sher River near Sehora.

Age—Bansa (Lower Cretaceous); other localities (Upper Jurassic-Lower Cretaceous).

Comparison—Araucaria pantiana differs from all the Indian species of *Araucarites* in having a prolonged tip. In *A. pantiana* the stomata are much more in number than *A. sehoraensis*. *A. pantiana* has mostly 4 subsidiary cells, whereas, in *A. sehoraensis* they are 4-7 in number. Moreover, in *A. sehoraensis* the ordinary cells are more broader and many of them are rounded at corners. *A. minutus* is much smaller in size and in this species the majority of the subsidiary cells are 5 in number. The cells over seed in *A. pantiana* are straight walled. In *A. minutus* the cells are narrower and they are often broken by pits. In general shape and size *A. pantiana* resembles most *Araucarites arberi* Walkom (1969) described from the *Burrum* Series of Queensland. Both have prolonged tip. Unfortunately, in the latter species the cuticular structure has not been described.

Amongst the conifers collected from Bansa and Sehora, the cuticle of *A. pantiana* resembles most the cuticle of *Desmiophyllum indicum* Sahni (1928) in general distribution of stomata and in the presence of hyaline areas at the poles of guard cells. These resemblances have already been pointed out by Sahni (1928) and Pant and Srivastava (1968).

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EXPLANATION OF PLATES

PLATE 1

1-5. *Araucarites cutchensis* Feistmantel: 1, G. S. I. no. 4848 (Lectotype); 2, B. S. I. P. no. 35070; 3, G. S. I. no. 4775; 4, G. S. I. no. 4815; and 5, B. S. I. P. no. 35078. ×1. Figures 1, 2, 4 from Kutch, figure 3 from Vemavaram and figure 5 from Songad.

6-9. *Araucarites sehoraensis* sp. nov.: 6. B. S. I. P. no. 35071; 7. B. S. I. P. no. 35073; 8. B. S. I. P. no 35072A; and 9, B. S. I. P. no. 35072D (Holotype). ×1.
All specimens from Sher River near Seohra.

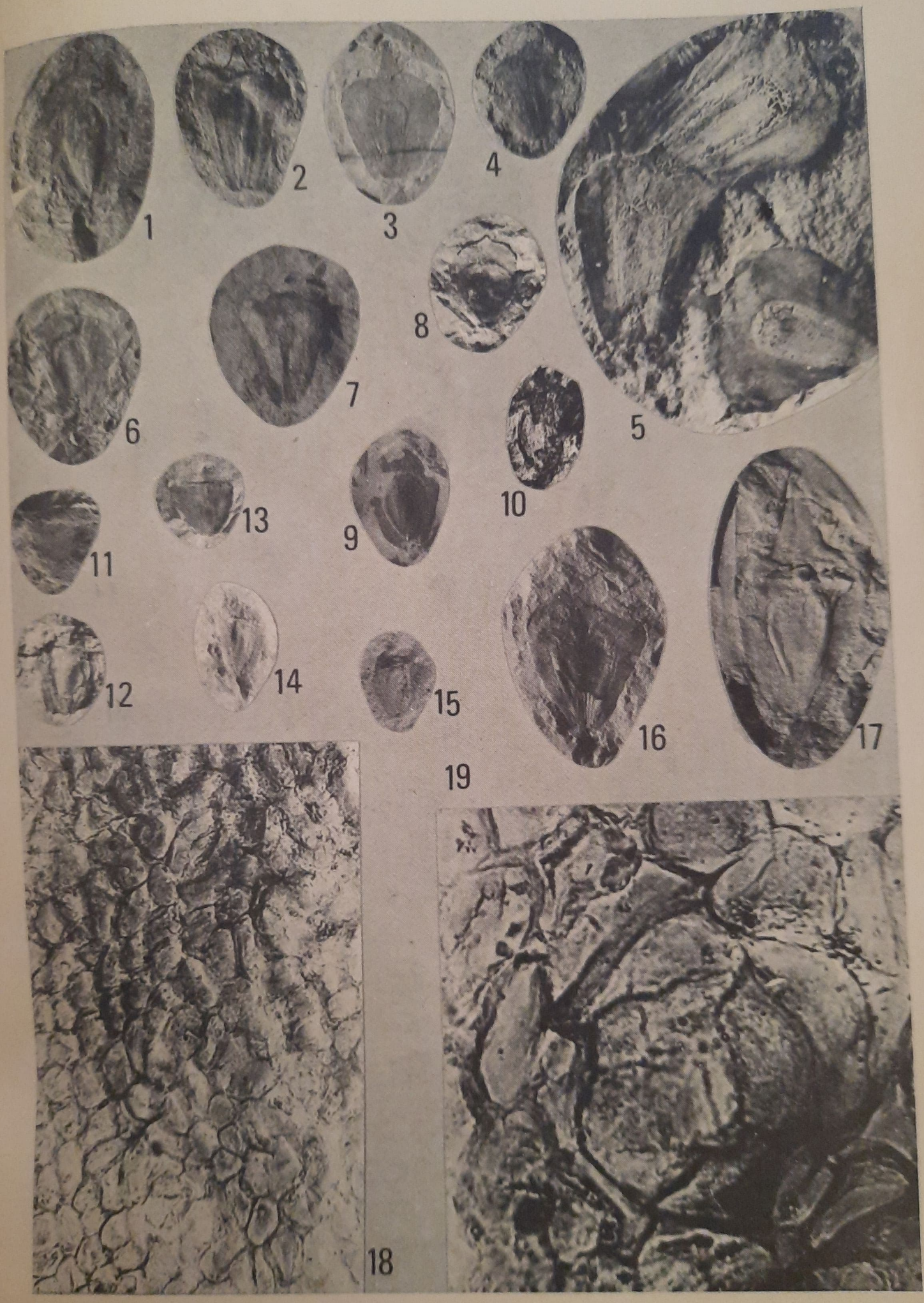
10-14. *Araucarites minutus* sp. nov.: 10, B. S. I. P. no. 29121 (Holotype); 11, B. S. I. P. no. 35074; 12, B. S. I. P. no. 35076; 13, G. S. I. no. 4737; 14, B. S. I. P. no. 29047; and 15, B. S. I. P. no. 35075. ×1.
Figure 13 from Vemavaram and the rest from Sher River near Sehora.

16-17. *Araucaria pantiana* sp. nov.: 16, B. S. I. P. no. 33841 ; 17, B. S. I. P. no. 33864. ×1. Both from Sher River near Sehora.

18. *Araucarites sehoraensis* sp. nov.: showing a few cells from the stomatal side. Slide no. 35072D-1 ×150.
19. *A. sehoraensis* sp. nov.: showing a stoma. Slide no. 35072D-2. ×500.

PLATE 2

20-23. *Araucaria pantiana* sp. nov.: 20, B. S. I. P. no. 30050; 21, B. S. I. P. no. 30062; 22, B. S. I. P. no. 30665; and 23, G. S. I. no. 4965. × 1.
Figures 20-22 from Bansa and figure 23 from Sher River near Sehora.
24. *A. pantiana* sp. nov.: showing distribution of stomata in single files. Slide no. 30100-1. × 150.
25. *A. pantiana* sp. nov.: showing a stoma. Slide no. 30100-1. × 500.
26. *Araucarites minutus* sp. nov.: showing distribution of stomata. Slide no. 35072B-1 × 150.
27. *A. minutus* sp. nov.: showing a stoma. Slide no. 35072B-1. × 500.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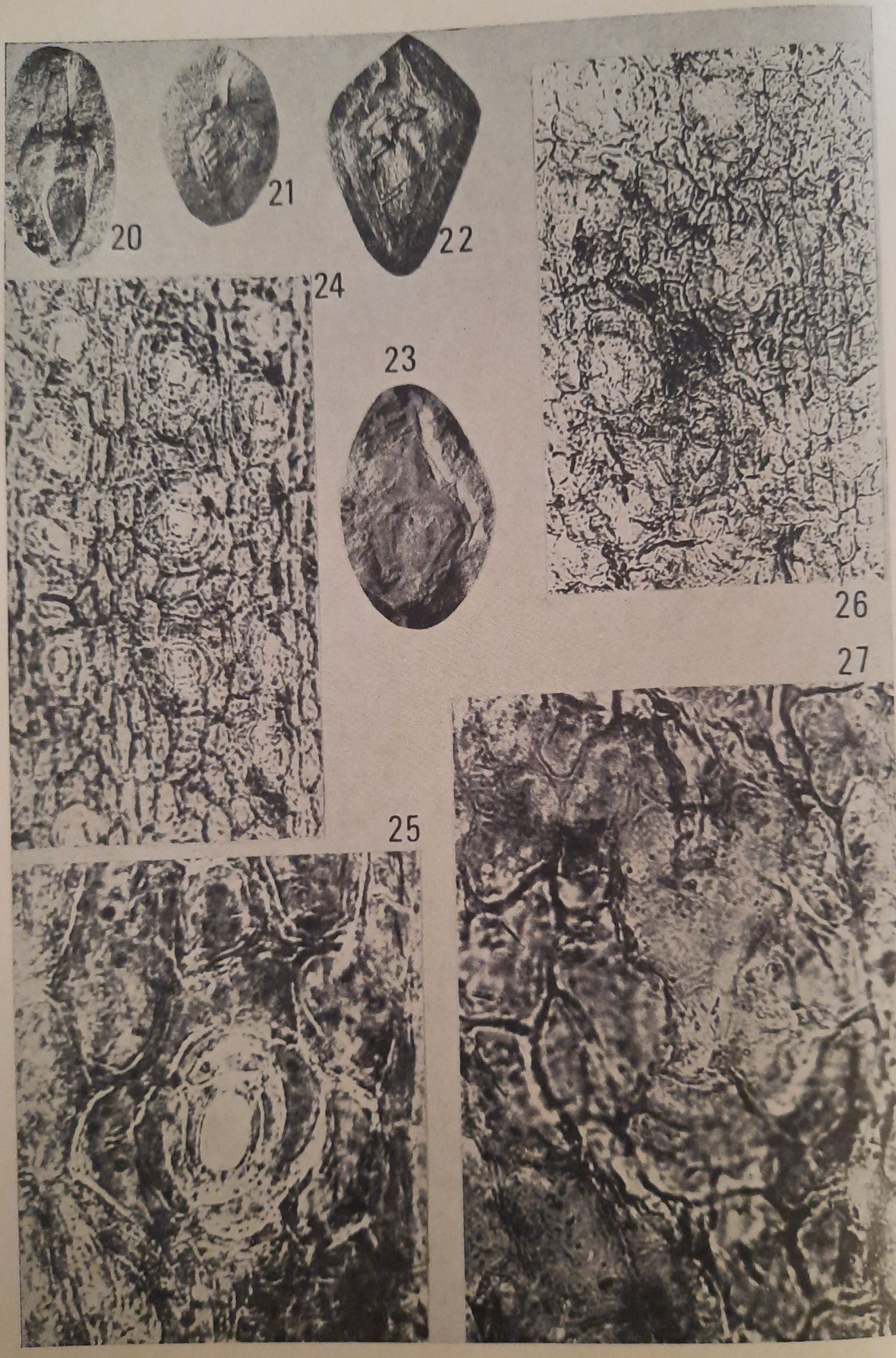
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