SOME MICRO- AND MEGASTROBILI FROM THE LOWER TRIASSIC OF GOPAD RIVER VALLEY, NIDPUR

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ABSTRACT

Further data obtained from some newly collected specimens of *Nidistrobus harrisianus* Bose & Srivastava (1973) are recorded here. An attempt has been made to reconstruct the microstrobilus.

The paper also records a few megastrobili whose cuticle is more like that of *Dicroidium nidpurensis* Bose & Srivastava (1971). These have been described as *Nidia ovalis* gen. et sp. nov. In *N. ovalis* the megasporophylls are attached in a close spiral and their overall appearance is somewhat like the female strobili of cycads, especially like *Zamia* etc.

INTRODUCTION

Recently Bose and Srivastava (1973) described a microstrobilus as *Nidistrobus harrisianus*. Since then a few more specimens belonging to this genus have been collected along with a large number of detached, 'pad-shaped' pollen-bearing organs. The new specimens have confirmed the previous interpretation of the pollen-bearing organs and have furnished some new information. Based on this information the earlier diagnosis of *Nidistrobus* has been revised here. Along with *Nidistrobus*, four megastrobili have also been collected from the Lower Triassic bed exposed in the Gopad river valley near Nidpur, Sidhi district. These resemble somewhat the megastrobilus of *Zamia*, but their cuticle is more like that of *Dicroidium*. They are here described under a new generic name *Nidia*.

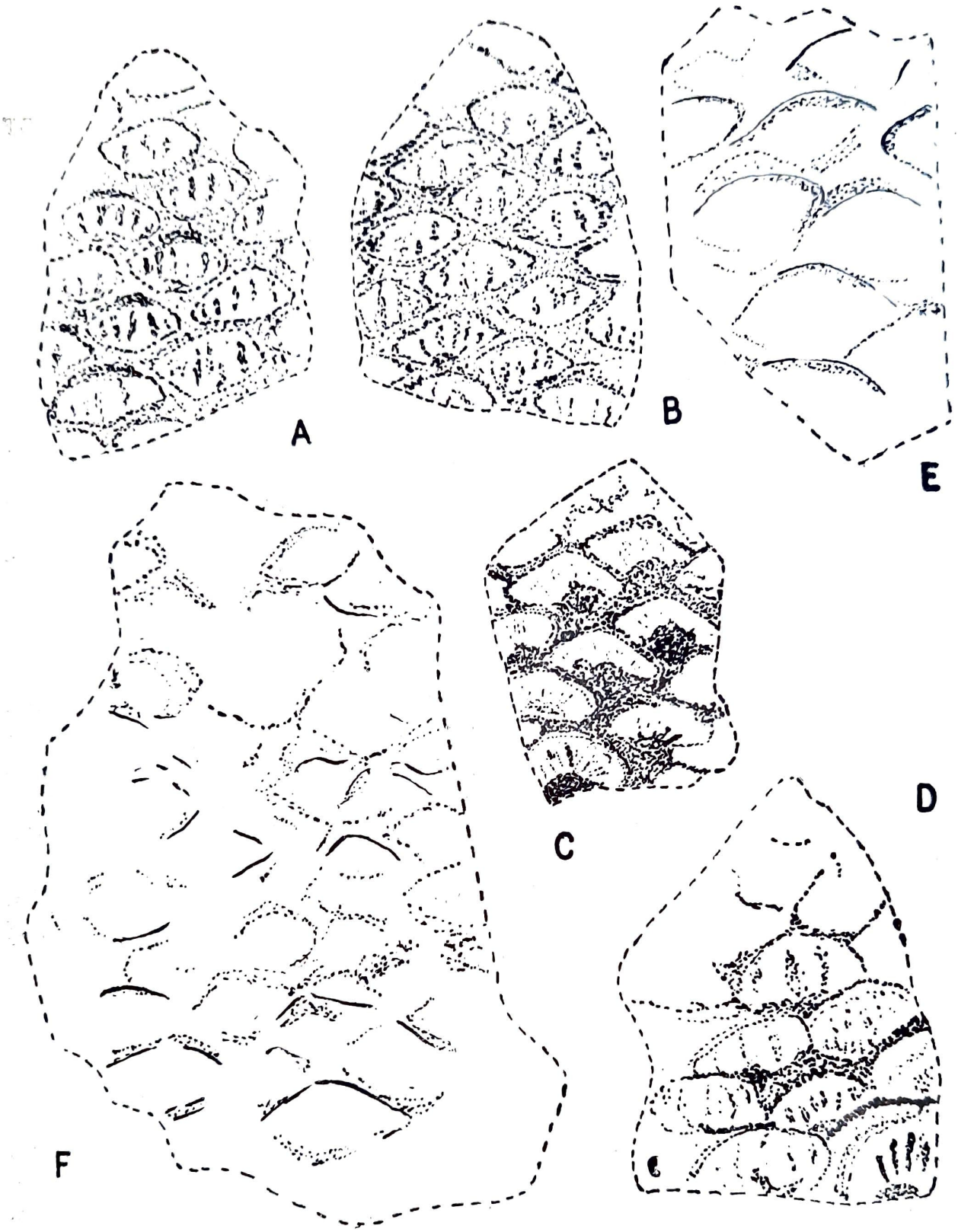
DESCRIPTION

Nidistrobus Bose & Srivastava

Emended Diagnosis—Male fructification with a broad axis. Axis bearing spirally arranged, short stalked, 'pad-shaped' pollen-bearing bodies. Each 'pad-shaped' organ having a row of 7-9 elliptic or oval pollen sacs on its adaxial side and perhaps embedded in its substance. Cuticle of stalk and pad-shaped body thick, stomata mostly confined to lower surface. Subsidiary cells 5-8 (usually 6), generally arranged in a ring. Encircling cells common. Guard cells sunken in a rectangular or rhomboidal pit, thinly cutinized, mostly not preserved. Cuticle of pollen sac extremely thin, cells polygonal. Pollen grains numerous in each pollen sac, bisaccate, non-striate.

Type Species—*Nidistrobus harrisianus* Bose & Srivastava, 1973

Remarks—Earlier, Bose and Srivastava (1973) had described the cuticle of the 'pad-shaped' bodies as amphistomatic. Now we have examined cuticular preparations out of a large

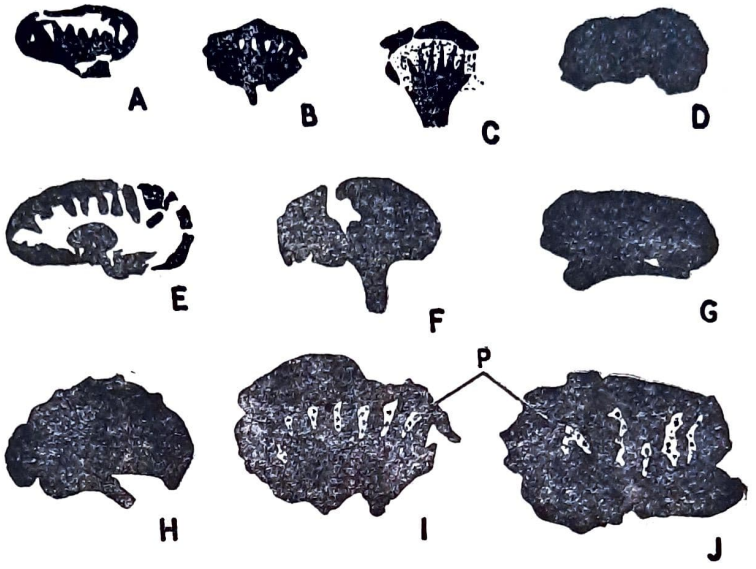


Text-fig. 1—*Nidistrobus harrisianus* Bose & Srivastava. A-B, holotype no. 35046, showing two sides of the part in compressed state, *ca* × 1. C-D, the two counterparts of the holotype no. 35046, *ca* × 1. E, no. 35064, *ca* × 1. F, the largest specimen so far collected, no. 35063, × 1.

number of such 'pad-shaped' bodies collected in dispersed condition. In almost all of them, idcluding the holotype, the stomata are confined to the abaxial side. Very rarely a few stomata may be observed on the adaxial side as well. Such stomata are confined near the apical margin with thick cuticle.

In most of the 'pad-shaped' bodies belonging to the holotype (Pl. 1, Fig. 1), as well as in the specimens obtained in dispersed condition, walls of the pollen-sacs have been found in disintegrated condition. However, in the holotype when the thick cuticle on the

abaxial side of the 'pad-shaped' bodies was removed with a needle, masses of pollen grains were observed on the matrix (core) within definite chambers. Such masses of pollen grains were also found in many of the dispersed 'pad-shaped' bodies (Pl. 1, Fig. 6; Text-fig. 2 I, J) which were preserved lying upside down. Here too, the pollen grains were observed on the matrix, within the area originally occupied by the pollen sacs, when the cuticle from the abaxial side was removed. It seems the cuticle of the pollen sacs was extremely delicate and during preservation it disintegrated leaving only the pollen grains between the radiating ribs of thick cuticle (Pl. 1, Fig. 6) which supported the pollen sacs.

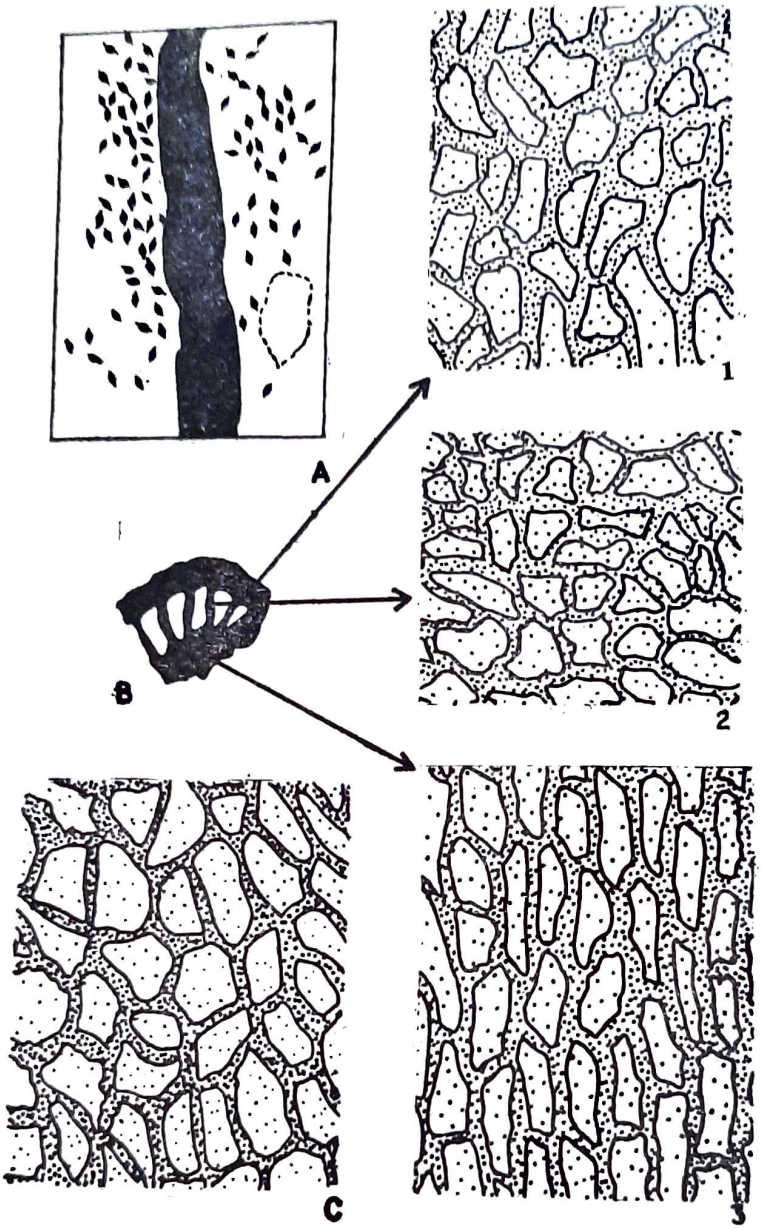


Text-fig. 2—*Nidistrobus harrisianus* Bose & Srivastava. A-J, a few detached 'pad-shaped' bodies. A, no. 35048. B, no. 35048 (counterpart). C, no. 35056 D, no. 35058. E, no. 35055. F, no. 35059. G, no. 35060. H, no. 35061. I, no. 35048 (counterpart). J, no. 35054. A-H, ×1; I-J, ×2 (P=pollen grains).

The pollen grains (Pl. 3, Fig. 15), recovered from the matrix just underneath the 'pad-shaped' bodies of the holotype and some of the dispersed specimens, are more like the holotype of *Satsangisaccites nidpurensis* described by Bharadwaj and Srivastava (1969, pl. 27, fig. 50). Along with these, a few pollen grains (pl.1,Figs. 7, 8) resembling the pollen grains of *Satsangisaccites triassicus* Bharadwaj & Srivastava (1969, pl. 27, figs. 61-68)have also been recovered. These pollen grains are bilateral, bisaccate, haploxylonoid, 71-88 μ long. Their central body outline is ill-defined, usually marked by a thickening along zones of saccus attachment. Sacci are more or less hemispherical, slightly distally inclined, their intrareticulation is coarse. Distal sulcus is broad and vertically oval. These smaller grains differ from *S. nidpurensis* in having a broad sulcus. Their size range is more than *S. triassicus* and unlike the latter species, they do not have the median groove. However, in some of the specimens of *S. triassicus* the median groove is not visible. In having a broad sulcus, these grains somewhat resemble *Klausipollenites* sp.cf. *K. staplinii* Herbst described by Bharadwaj and Srivastava (1969, pl. 28, figs. 73-77), but they differ in having a larger size range.

In addition to the two types of pollen grains recovered, other types of pollen grains have also been observed in some 'pad-shaped' bodies though in smaller numbers. Now a doubt has naturally arisen as to which type of pollen grain was produced by *Nidistrobus*. At present, it is difficult to say that because so far we have failed to macerate a complete pollen-sac. Until and unless that is done the origin of the two major types of pollen grains (Pl. 1, Figs. 7-8 and Pl. 3, Fig. 15) will be difficult to ascertain. As such we have deleted the description of these pollen grains from the emended diagnosis. However, in spite of the

present uncertainty concerning the nature of the pollen grains contained in *Nidistrobus*, it is highly probable that its pollen grains were non-striate, haploxylonoid, bisaccates approaching the organization as in *Satsangisaccites*.



Text-fig. 3—*Nidistrobus harrisianus* Bose & Srivastava. A, showing distribution of stomata on the abaxial surface, sl. no. 35067, ×20. B, adaxial surface of a 'pad-shaped' body, sl. no. 35065, ×2. B 1-3, showing cells on the adaxial surface at different levels, sl. no. 35065, ×250. C, showing cells on the abaxial side of a 'pad-shaped' body, sl. no. 35067, ×250.

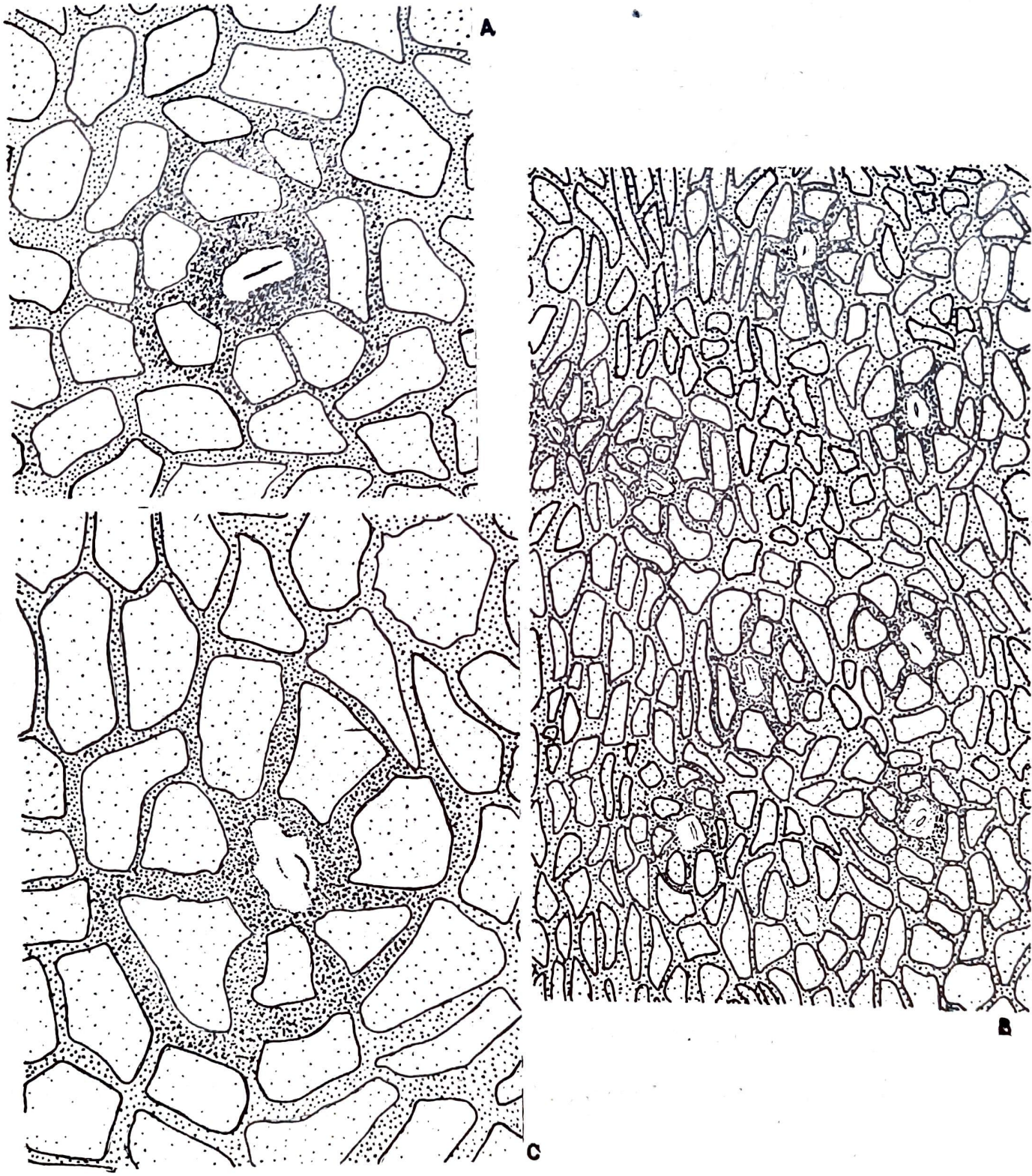
Nidistrobus harrisianus Bose & Srivastava

Pl. 1, Figs. 1-6, Pl. 2, Fig. 14; Text-figs. 1-4 B-C, 5 A-C

1973 *Nidistrobus harrisiana* Bose & Srivastava, p. 211, pl. 1, figs. 1-5.

Diagnosis—Microstrobilus exceeding 15 cm in length and 7.5 cm in diameter. Axis broad, bearing spirally arranged, short stalked,'pad-shaped' pollen-bearing bodies. Stalk 4-7 mm long, 3-5 mm wide. Cells of stalk on adaxial side serially arranged, rectangular, sometimes polygonal; lateral and end-walls thick, straight; surface unspecialized. On

abaxial side, cells rectangular or polygonal, thick walled, rarely broken by pits. Stomata mostly confined to abaxial side. Subsidiary cells 5-8, mostly 6, occasionally 5, devoid of papillae. Encircling cells common. Guard cells sunken, thinly cutinized, mostly not preserved. 'Pad-shaped'body 1-2 cm long and 0.7-1.3 cm broad, having a row of 7-9 elongated pollen sacs on its adaxial side and perhaps embedded in its substance. Cuticle of 'pad-shaped' body thick, stomata confined to abaxial side. Cells on adaxial side rectangular or polygonal, serially arranged; lateral-and end-walls thick and straight, sometimes broken by pits; surface smooth, rarely unevenly thickened at places. Cells on abaxial side rect-



Text-fig. 4—*Nidia ovalis* gen. et sp. nov., showig a stoma of a megasporophyll, sl. no. 35053A-2, ×500. B, *Nidistrobus harrisianus* Bose & Srivastava, showing a few stomata on the abaxial surface of a 'pad-shaped' body, sl. no. 35067, ×200. C, a stoma on the abaxial side of a 'pad-shaped' body of *N. harrisianus*, sl. no. 35067, ×500.

angular or polygonal, thick walled, sometimes slightly wavy or broken by pits; surface wall smooth or mottled, rarely showing irregular thickening. Stomata irregularly distributed, longitudinally or obliquely placed. Subsidiary cells usually 6-7, sometimes 5 or 8, arranged in a ring, walls thick and straight, surface mostly unspecialized, sometimes surface slightly more cutinized at places, never forming definite papillae. Encircling cells usually present, like ordinary epidermal cells. Guard cells sunken in an oval or rectangular pit, mostly not preserved, thinly cutinized.

Wall of pollen sac extremely delicate. Cells polygonal with smooth surface. Numerous bisaccate, non-striate pollen grains in each pollen sac.

Holotype—No. 35046 of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality—Gopad river valley, near Nidpur, Sidhi district, Madhya Pradesh.

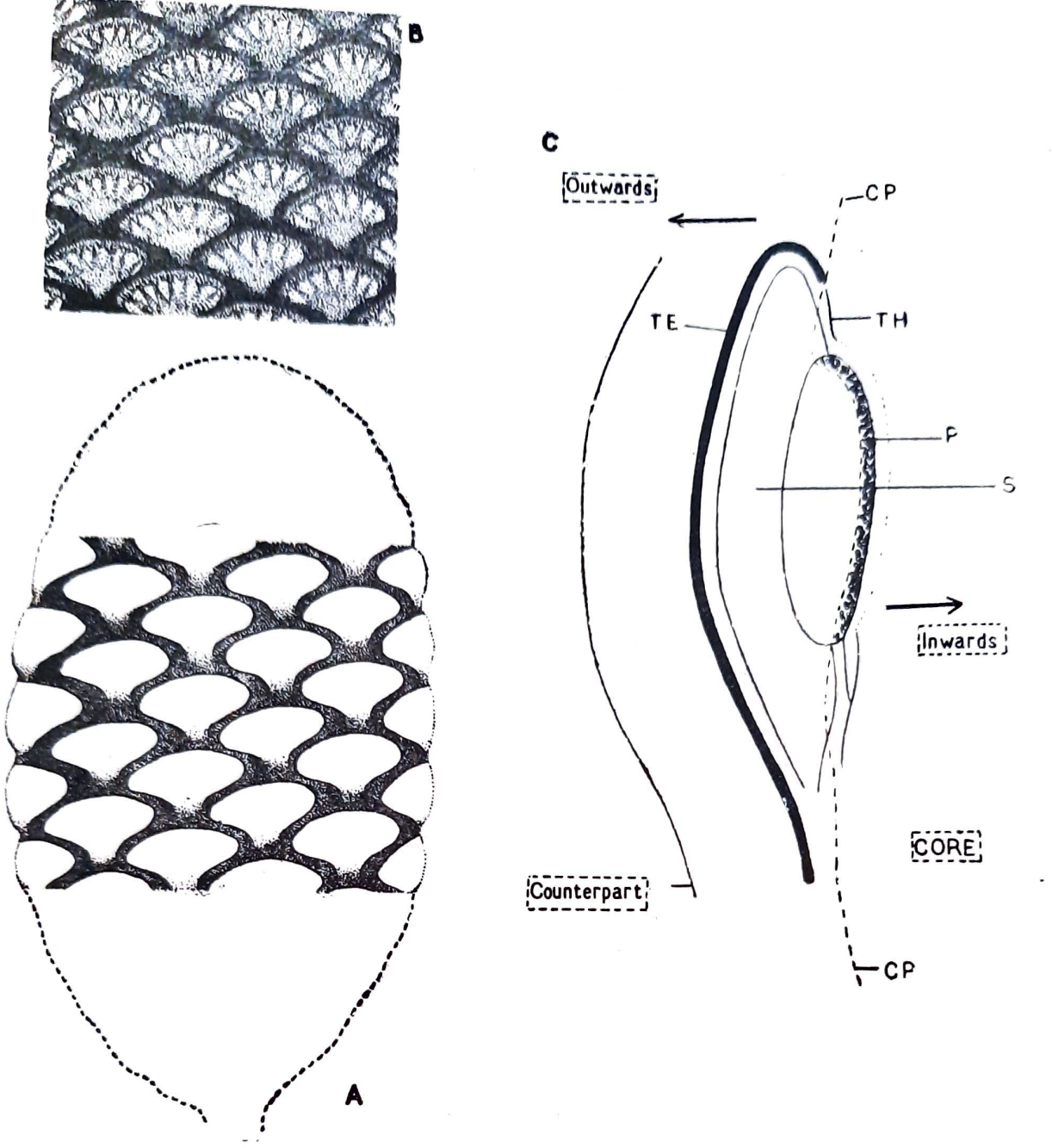
Age—Lower Triassic.

Description—The holotype consists of the part (Pl. 1, Fig. 1; Text-fig. 1A-B) and two counterparts (Pl. 1, Figs. 2-3; Text-fig. 1C-D). It measures about 6 cm in length and is incomplete both at apex and base. It is estimated the specimen exceeded 15 cm in length. The 'pad-shaped' bodies are all arranged spirally around the main axis. But in the main axis or the core there is no organic remain preserved. It has all been replaced by silica and is preserved in the form of a cast. When the cuticle of the 'pad-shaped' bodies is removed from abaxial side the pollen grains are visible only on the cast (matrix) of the main axis. Most of the pollen grains are like *Satsangisaccites nidpurensis* Bharadwaj & Srivastava (1969, Pl. 27, fig. 50). Along with these a few other types of pollen grains are also met with. There is, however, no pollen grain present in the counterparts. From this Bose and Srivastava (1973, p. 212) had inferred that the pollen sacs were adaxially placed. In order to show the position of the pollen sacs in relation to the main axis, here an imaginary radial longitudinal section of a 'pad-shaped' body has been given in text-figure. 5C.

The largest specimen so far collected (Text-fig. 1F) measures 10.5×7.5 cm. The specimen shows a large number of spirally arranged 'pad-shaped' bodies. This specimen and the one figured in Text-fig. 1E seem to be counterparts of different specimens whose main parts are missing. Besides these specimens a large number of detached 'pad-shaped' bodies (Text-fig. 2A-J) has been collected and also obtained by bulk maceration. In most of them the cuticular structure is the same. In very rare cases a few cells have been found to be papillate. In all these, on the adaxial side, cells near base are serially arranged in longitudinal direction (Text-fig. 3B 1-3) and the cells along the radiating ribs, which supported the pollen-sacs, are also serially arranged but are in transverse direction. The cells near apex are either longitudinally placed or irregularly arranged.

The cuticle of the pollen sacs seems to be extremely delicate. With great difficulty, a few cells could be observed while macerating the cuticle under the coverslip. The cells are polygonal. In almost all the specimens it seems the wall of the pollen sacs disintegrated either before preservation or during preservation. That is why besides *Satsangisaccites*-type of pollen grains, which are in large majority, other types of non-striate, bisaccate grains are also met with.

Based on all these specimens, here an attempt has been made to reconstruct the micro strobilus. Text-figure 5A shows the partial restoration of *Nidistrobus harrisianus*. The restoration is based on the holotype and as the holotype is incomplete, both at apex and base, so in the restoration the apical and basal regions have been left incomplete. The restoration of the 'pad-shaped' bodies as seen from the adaxial side (Text-fig. 5B) is based mainly on detached specimens and specimens isolated by bulk maceration.

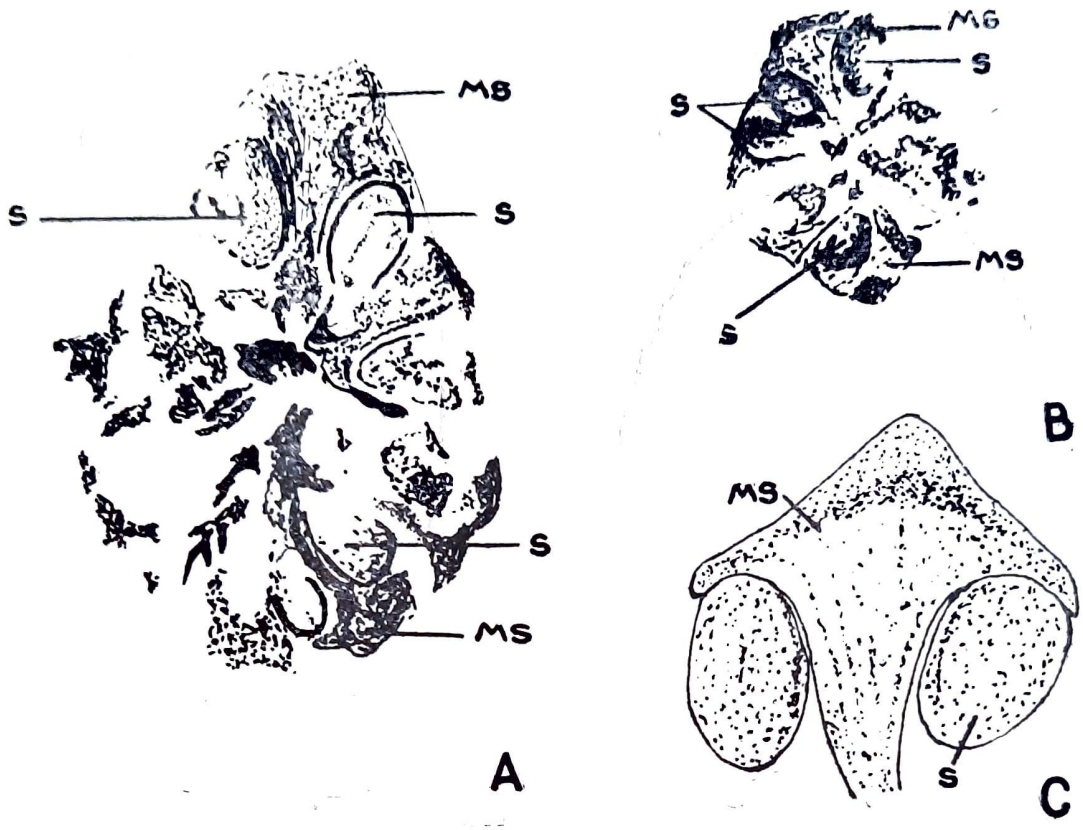


Text-fig. 5—*Nidistrobus harrisianus* Bose & Srivastava. A, partial restoration of the microstrobilus. B, restoration of a few 'pad-shaped' bodies as seen from the adaxial surface, about nat. size. C, imaginary radial longitudinal section of a 'pad-shaped' body (CP-cleavage plane, P-pollen grains, S-soft tissue with stone-cells, TE-thick cuticle, TH-thin cuticle).

Comparison—Bose and Srivastava (1973, p. 212) have already pointed out the differences between *Nidistrobus harrisianus* and *Harrisiothecium marsilioides* (Lundblad) Lundblad (1961). The major differences lie in the shape and arrangement of the pollen-bearing organs. Unlike *N. harrisianus*, in the latter species pollen grains were contained in capsules with two valves. The cuticular structure of the 'pad-shaped' bodies of *N. harrisianus* is more like *Dicroidium nidpurensis* Bose & Srivastava (1971). However, in the 'pad-shaped' bodies of *N. harrisianus* stomata are confined to the lower surface and the subsidiary cells are usually 6-7 in number. In *D. nidpurensis* the cuticle is amphistomatic and the subsidiary cells are usually 5 in number.

Nidia gen. nov.

Diagnosis—Female cone consisting of an axis bearing spirally arranged megasporophylls. Megasporophylls closely set, consisting of a stalk enlarging into an expanded distal head; cuticle of megasporophyll thick, amphistomatic, subsidiary cells usually 6. Head bearing two inward pointing seeds on either sides of the stalk; seeds sessile, (?) orthotropous; seed integument moderately thickly cutinized.



Text-fig. 6—*Nidia ovalis* gen. et sp. nov. A, holotype no. 35053, ×2. B, counterpart of the holotype, ×1. C, digrammatic representation of a megasporophyll (MS-megasporophyll, S-seed) in compressed state.

Type Species—*Nidia ovalis* gen. et sp. nov.

Derivation of name—After the type locality Nidpur.

Nidia ovalis gen. et sp. nov.

Pl. 2, Figs. 9-13; Pl. 3, Figs. 16-17; Text-figs. 4A, 6-8

Diagnosis—Female cone, shape as a whole oval, 3-3.8 cm long, 2.1-2.5 cm in diameter. Axis 1.5-2 mm wide, prominently striated. Cells of axis rectangular or polygonal, serially arranged; walls thick and straight, at places slightly wavy; surface usually smooth sometimes unevenly thickened but without definite papillae. Stomata few, irregularly scattered, mostly longitudinally orientated. Guard cells thinly cutinized. sunken. Subsidiary cells 5-6, rarely 7; lateral-and end-walls thick; surface smooth or unevenly thickened.

Sporophylls 1-1.3 cm long and 1-1.2m broad at its broadest region, attached at right angles in a close spiral. Stalk longitudinally striated; head somewhat rhomboidal, wrinkled, apex bluntly pointed. Sporophyll cuticle on both sides similar, amphistomatic. Cells polygonal or rectangular; lateral-and end-walls straight, thick, surface smooth, sometimes mottled. Stomata dicyclic, irregularly scattered on both surfaces, usually longitudinally orientated, some oblique or transverse. Subsidiary cells mostly 6 (range noted

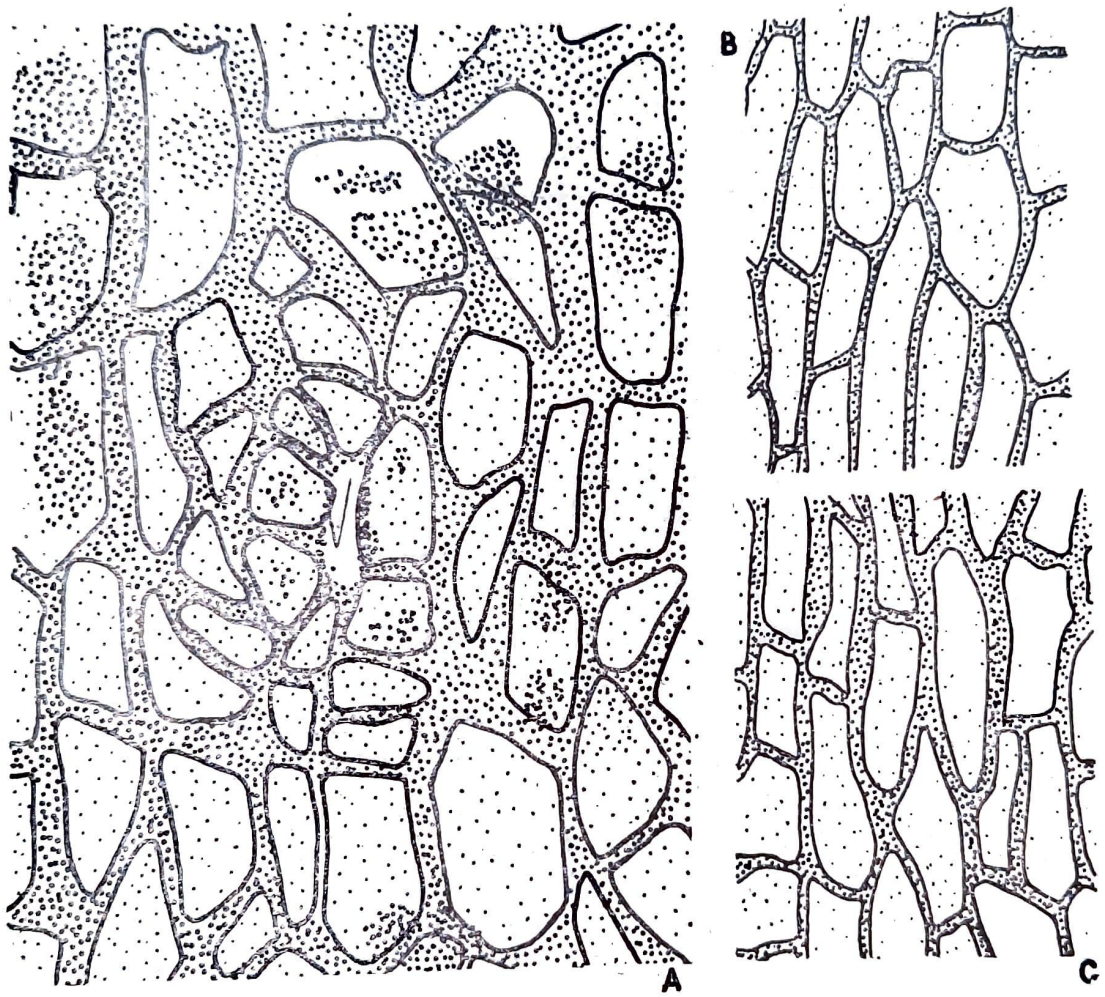
5-8); lateral- and end-walls straight, thick; surface wall smooth, sometimes unevenly thickened. Encircling cells usually present, like ordinary epidermal cells. Guard cells thinly cutinized, usually not preserved, sunken.

Seeds more or less oval, 6-8 mm long, 3-5 mm broad. Seed integument moderately thick, devoid of stomata. Cells elongated, usually rectangular, sometimes polygonal, serially arranged in longitudinal direction.

Holotype—No. 35053 of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality—Gopad river valley, near Nidpur, Sidhi district, Madhya Pradesh.

Age—Lower Triassic.



Text-fig. 7—*Nidia ovalis* gen. et sp. nov. A, a stoma from the main axis, sl. no. 35051A-1, ×200. B, a few cell, of a megasporophyll, sl. nos 35053A-1, ×250. C, a few cells from the main axis, sl. no. 35051A-1s ×250.

Remarks—The above description is based on four specimens. Out of these, the preservation in the holotype (Pl. 2, Figs. 9, 10) is the best. While good cuticular preparations could be made out of the sporophylls, from the seeds only fragmentary pieces could be obtained. Except the cuticular structure of the integument no other details of the seeds are available at present.

Comparison—*Nidia ovalis* differs from *Beania gracilis* Carruthers and *B. mamayi* Thomas & Harris described by Harris (1964) in being much compact. In the compact nature of the cone the former comes more closer to the extant genus *Zamia*. The cuticle of *N. ovalis* resembles

Dicroidium nidpurensis Bose & Srivastava (1971) and *Nidistrobus harrisianus* Bose & Srivastava (1973). In all these species the stomata are irregularly scattered and they have non-papillate epidermal cells. In *N. ovalis* the subsidiary cells are mostly 6 in number. In this respect it resembles more *N. harrisianus* and not *D. nidpurensis* where the subsidiary cells are mostly 5 in number. In *N. ovalis* and *D. nidpurensis* the cuticle is amphistomatic, whereas, in *N. harrisianus* the stomata are mostly confined to the lower side of the 'pad-shaped' bodies.

DISCUSSION

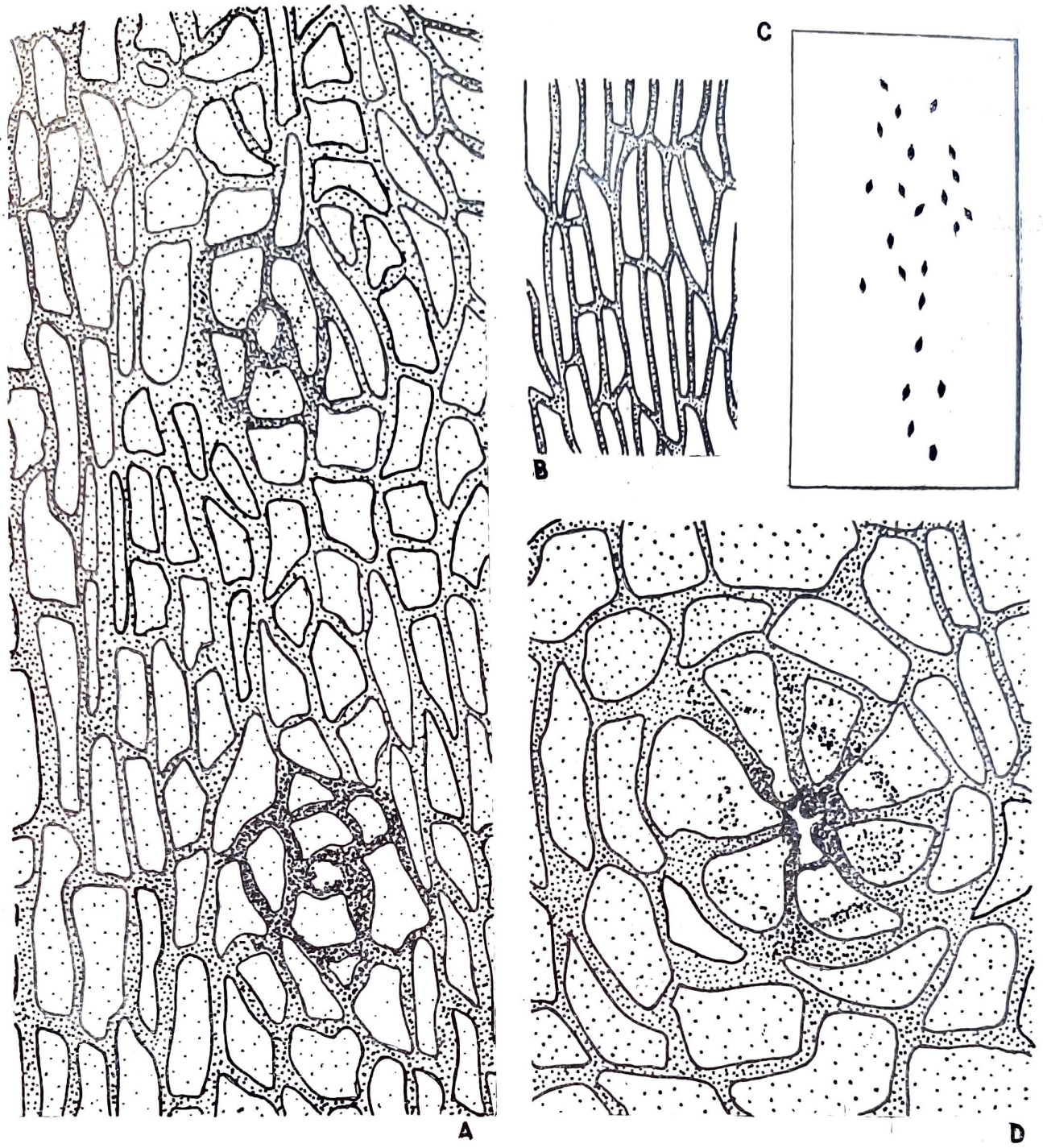
In the Lower Triassic of Gopad river valley near Nidpur, the genus *Dicroidium* is most abundant. They are preserved almost in the same manner as *Pachypteris papillosa* (Thomas & Bose) Harris (1964) at Roseberry Topping, Yorkshire. Besides *Dicroidium*, amongst the fronds, a few species of *Glossopteris* (see, SRIVASTAVA, 1969, 1971), *Rhabdotaenia* sp., and *Taeniopteris glandulata* Srivastava (1971) are also present, though in small number. In addition to these, three specimens of *Noeggerathiopsis* and a specimen each of *Lepidopteris indica* Bose & Srivastava (1972) and a conifer shoot (see, SRIVASTAVA, 1971) have so far been collected.

As has already been pointed out, the cuticles of *Nidistrobus harrisianus* and *Nidia ovalis* resemble most the cuticle of *Dicroidium nidpurensis* Bose & Srivastava (1971). The cuticle of *N. harrisianus* agrees perfectly with *N. ovalis*, except that in the former genus the stomata are mostly confined to the abaxial side of the 'pad-shaped' bodies. In *N. ovalis* the cuticle is amphistomatic like *D. nidpurensis*. Both *N. harrisianus* and *N. ovalis* differ from *D. nidpurensis* in having mostly 6 subsidiary cells. In *D. nidpurensis* the subsidiary cells are mostly 5 in number. But in all these the subsidiary cells range 5-8 in number.

The general structure of the epidermal cells and the stomata of *N. harrisianus* and *N. ovalis* agrees so much with *D. nidpurensis* that it is difficult to separate the three on the basis of cuticle. The close association and the structural agreement between the cuticles suggest *D. nidpurensis*, *N. harrisianus* and *N. ovalis* were perhaps related to each other. In case *N. harrisianus* and *N. ovalis* were the fertile organs of *D. nidpurensis* the plants which bore these organs were quite different from the so-called Mesozoic pteridosperms known from the Northern Hemisphere. *N. harrisianus* is distinct from *Harrisiothecium* Lundblad (1961), because the former is more compact and the 'pad-shaped' pollen-bearing organs are spirally arranged. In the latter, the pollen-bearing organs are capsule-like which are composed of two valves. The female cone, too, is unlike any of the female cones assigned to the so-called Mesozoic pteridosperms. Actually, *N. ovalis* is more cycad-like. It is more compact than *Beania* and approaches *Zamia* in general form. Unfortunately, in *N. ovalis* the structural details of the seeds are still not known. So, at present, its detail comparison with *Beania* and *Zamia* is not possible. But whatever little is known of *N. ovalis*, it suggests a more cycad-like affinity.

ACKNOWLEDGEMENTS

One of us (M.N.B.) had the opportunity of showing some of the specimens and slides of *Nidistrobus harrisianus* Bose & Srivastava and *Nidia ovalis* gen. et sp. nov. to Professor T. M. Harris, F.R.S. of the University of Reading. We are most grateful to him for his valuable suggestion.



Text-fig. 8—*Nidia ovalis* gen. et sp. nov. A, showing a few stomata, sl. no. 35053A-1, ×200. B, cells of the outer surface of a seed, sl. no. 35053B-1, ×250. C, showing stomatal distribution on one of the surfaces of a megasporophyll, sl. no. 35053A-1, ×20. D, a stoma from a megasporophyll, sl. no. 35053A-II, ×500.

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EXPLANATION OF PLATES

PLATE 1

Nidistrobus harrisianus Bose & Srivastava

1. Part, holotype no. 35046. × 1.
2-3. Counterparts of the holotype. × 1.
4. Showing distribution of stomata on the abaxial side of a 'pad-shaped' body; sl. no. 35067-1. ×100.
5. A stoma magnified; sl. no. 35067-1. ×200.
6. Showing masses of pollen grains (P) on the matrix between the radiating ribs of thick cuticle (T) which supported the pollen sacs before disintegration; no. 35068. ×14.
7-8. Two non-striate, bisaccate pollen grains; sl. nos. 35057-A and 35066-A. ×500.

PLATE 2

Nidia ovalis gen. et sp. nov.

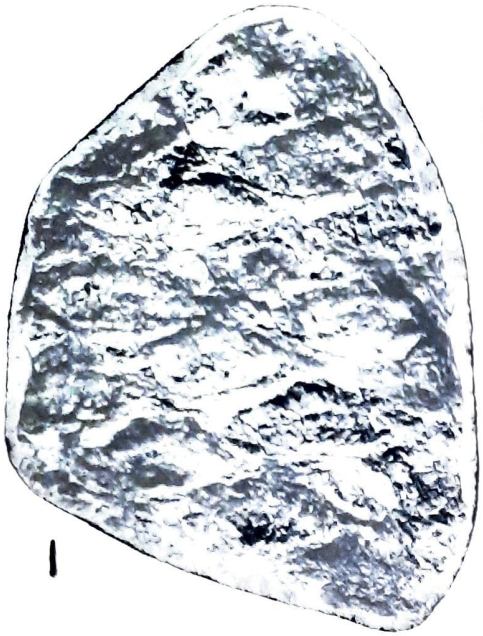
9-10. Part and counterpart; holotype no. 35053. ×1.
11. A stoma from the main axis; sl. no. 35051A-1. ×500.
12. Portion of a cuticle showing a few stomata; sl. no. 35053 A-1. ×100.
13. A stoma magnified; sl. no. 35053 A-1. ×500.

Nidistrobus harrisianus Bose & Srivastava

14. A stoma on the abaxial side of a 'pad-shaped' body; sl. no. 35046-1. ×500.

PLATE 3

15. A pollen grain resembling *Satsangisaccites nidpurensis* Bharadwaj & Srivastava; sl. no. 35062-1. ×500.
16. *Nidia ovalis* gen. et sp. nov.; holotype no. 35053. ×2.
17. A megasporophyll enlarged from the above, showing the two seeds (S). ×10.



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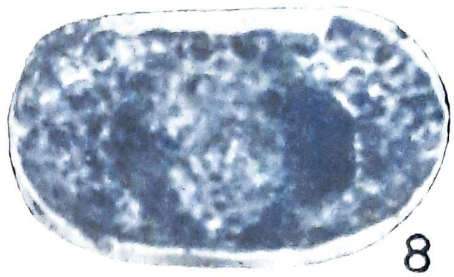

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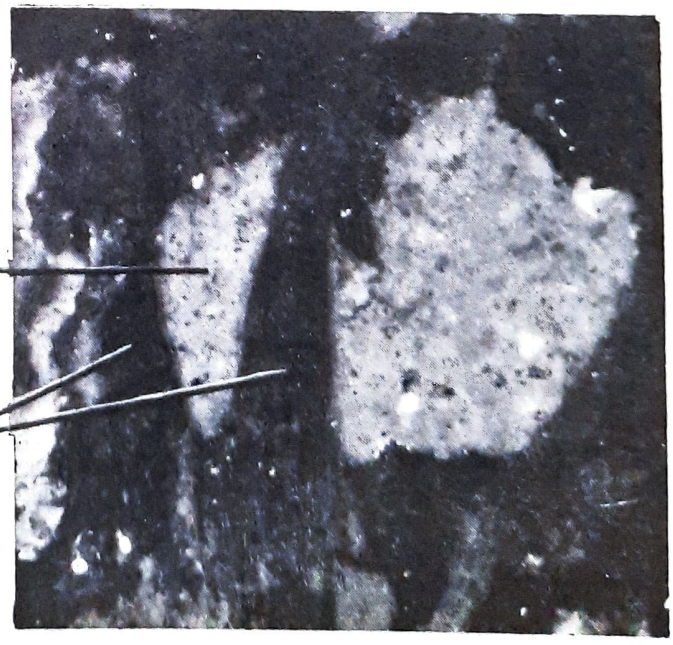

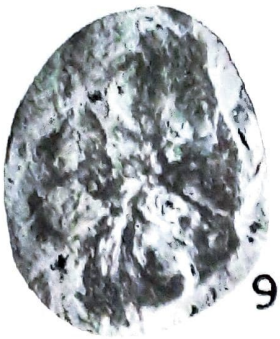

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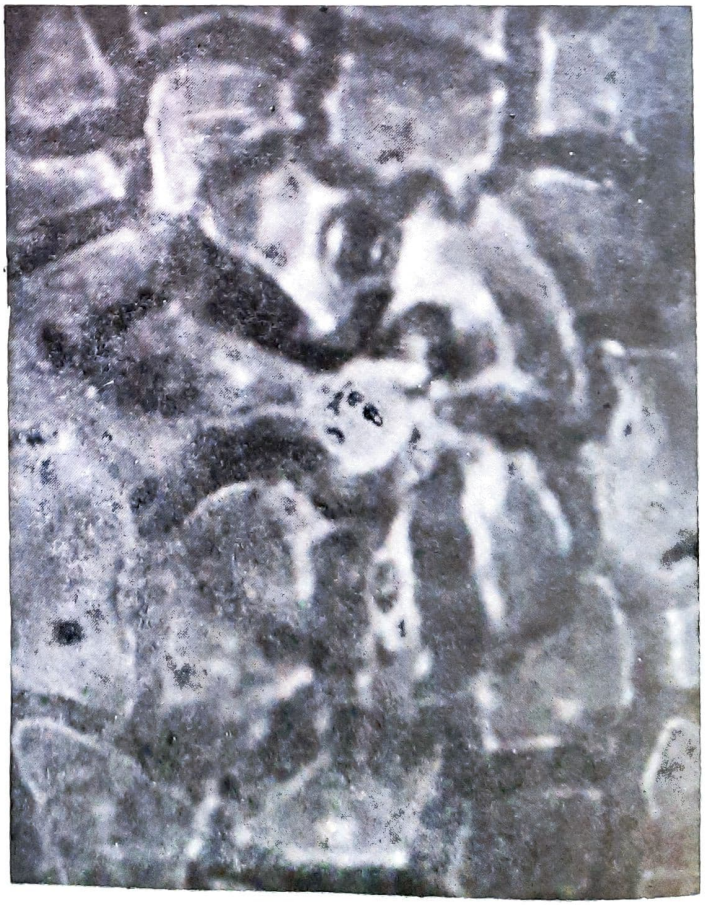

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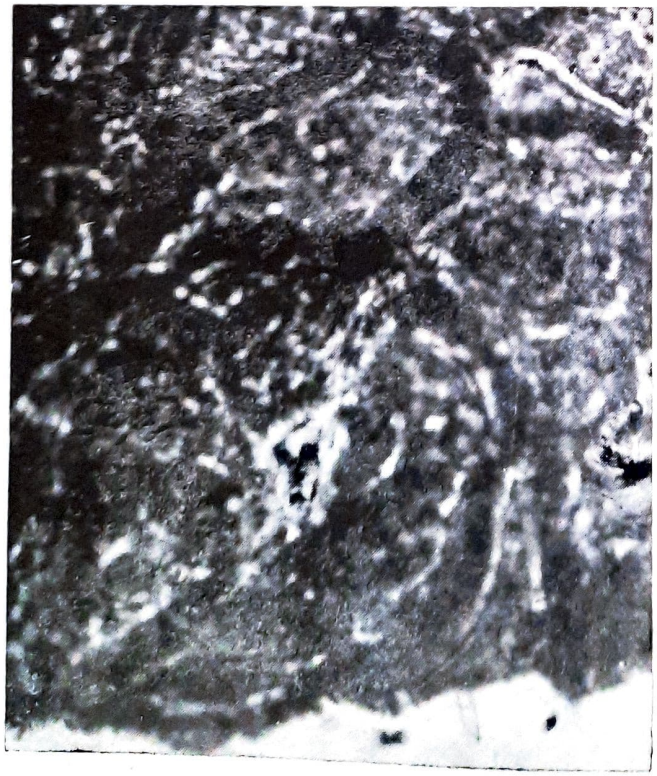

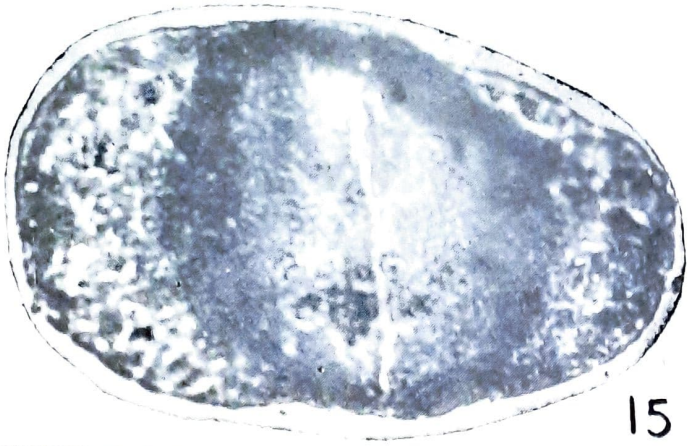

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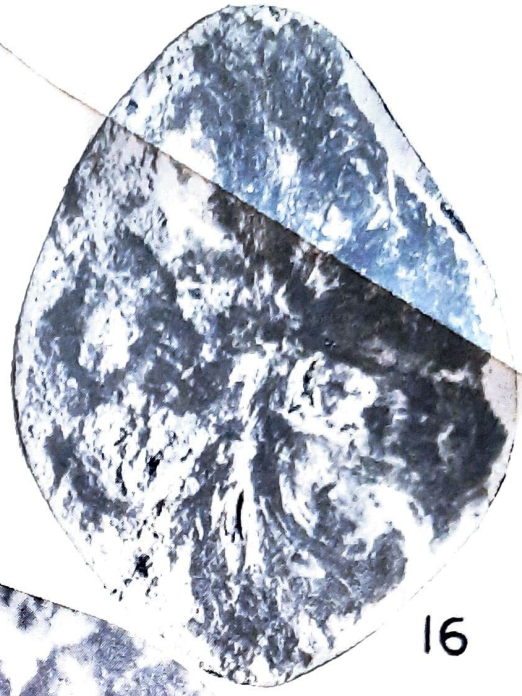

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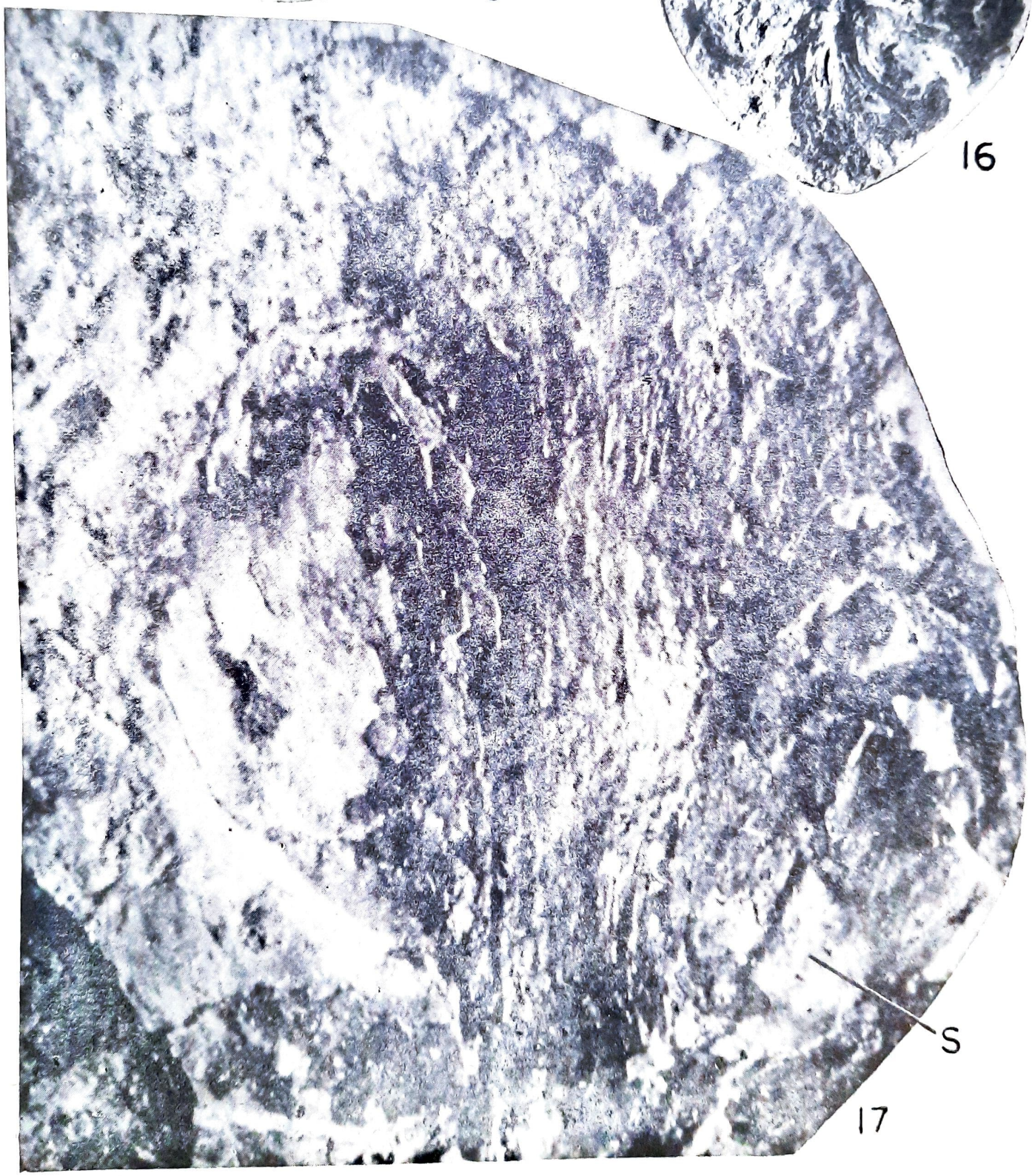

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