

Nidianthus gen. nov. - A *Caytonanthus* - like pollen organ from the Triassic of Nidpur, M.P., India

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ABSTRACT

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Nidianthus indicus gen. et sp. nov. is a synangiate pollen organ represented by more than 30 detached specimens. The compressed synangia were isolated from the Nidpur beds by bulk maceration of the Triassic shale in HF. Each synangium is elongated, radially symmetrical, appearing four-winged with a short axial attachment at base possibly representing ultimate branchlet. The four elongated pollen sacs remain attached at the base of synangium but appearing attached or free in middle and apical regions leaving four gaps at the time of dehiscence. The apical region of each pollen sac is pointed and bent inward towards the centre of synangium. Each pollen sac dehisces by a longitudinal slit along the midline of inner face. The surface of pollen sacs shows longitudinal striations. Some specimens showed a quadrangular abscission scar at the base of synangium. Cuticle of pollen sac wall showed elongated, rectangular to polygonal cells seemingly arranged in longitudinal files. Anticlinal walls thin, obscure, straight or slightly wavy. Cells become narrow towards the inner margin. Many cells of pollen sac wall showed median papilla bases and cells near the apical region showed cutinized unicellular hairs. Sometimes, remains of an inner, obscurely cellular, granular membrane possibly representing a tapetal layer could also be seen on inner side of pollen sac wall. Inside each pollen sac is a single mass of pollen-grains. Pollen-grains bisaccate, bladders hemispherical or obovate showing irregular surface reticulum. *Nidianthus* gen. nov. closely resembles the anther-like pollen organ *Caytonanthus* of Caytoniales.

Key-words—*Nidianthus* gen. nov., Quadrangular synangia, Nidpur, Triassic, *Sagenopteris*, Tapetum, *Caytonanthus*.

भारत में मध्य प्रदेश के निदपुर के ट्राइसिक से प्राप्त कैटोनेन्थस पराग अंग जैसा निदिएन्थस नवम वंश

नूपुर भौमिक एवं शबनम परवीन

सारांश

निदिएन्थस इंडिकस नवप्रजातिवंश 30 से ज्यादा अलग नमूनों द्वारा निरूपित एक संधानी पराग अंग है। संपीडित संधान एच एफ में ट्राइएसिक शैल के स्थूल मसुगन द्वारा निदपुर संस्तरों से पृथक हो गए थे। प्रत्येक संधानी अंतिम उपशाखा निरूपित करते हुए संभवतः आधार पर लघु अक्षीय संलग्नता सहित चार-पंखी दिखता हुआ दीर्घित, त्रिज्यतः सममित है। संधानी के आधार पर चार दीर्घित पराग थैलियां शेष संलग्न किंतु स्फुटन के समय 4 दर्रा छोड़ती हुई मध्य एवं शीर्ष मंडलों में संलग्न या मुक्त प्रतीत हो रही हैं। हरेक पराग शैली का शीर्ष मंडल संधानी की ओर इंगित एवं केंद्र की ओर अंदर की तरफ झुका है। प्रत्येक पराग थैली भीतरी मुखपट्टा के मध्य रेखा के सहारे एक अनुदैर्घ्य झिरी द्वारा स्फुटित है। पराग थैलियों का पृष्ठ अनुदैर्घ्य धारियां दर्शाता है। कुछ नमूनों ने संधानी के आधार पर चतुर्भुजी विलगन के निशान दर्शाए। पराग थैली दीवार की उपत्वचा ने अनुदैर्घ्य संचिका में प्रकृता से व्यवस्थित दीर्घित, आयताकार से बहुभुजी

कोशिकाएं दर्शाईं। अपनतिक पतली दीवारों, सीधे अल्पदृश्य या थोड़ी तंत्रगायित। भीतरी उपांत की तरफ कोशिकाएं संकुचित हो जाती हैं। बहुत-सी पराग थैली दीवारों ने माध्यक अंकुरक दर्शाए तथा शीर्ष मंडलों के नजदीक कोशिकाओं ने क्यूटिनमय एककोशिक रोम दर्शाए। कभी-कभार, संभवतः टेपटल परत निरूपित करते हुए भीतरी, अल्पदृश्यता कोशिक, दानेदार झिल्ली के अवशेष भी पराग थैली दीवारी के भीतरी तरफ देखे जा सके। प्रत्येक पराग के भीतर पराग-कणों का एक अकेला स्थूल है। पराग-दाने द्विसुपुटी, अर्धगोलीय थैली या प्रतिअंडाकार अनियमित पृष्ठीय जालिका दर्शा रही है। *निदिएन्थस* नवमवंश कैटोनिएल्स के परागकोश-जैसा पराग *कैटोनेन्थस* से बहुत मिलता-जुलता है।

मुख्य शब्द - *निदिएन्थस* नवमवंश, चतुर्भुजी संधान, निदपुर, ट्राइऐसिक, सगेनोपेटेरिस, टेपटम, *कैटोनेन्थस*।

INTRODUCTION

THE fossiliferous Nidpur beds discovered by Satsangi (1964) are located in the Gopad River section near Nidpur Village, Marhwas area, Sidhi District, Madhya Pradesh, India and contain a treasure of structurally preserved plant fossils as carbonaceous compressions on grey coloured micaceous shale. They abound in detached leaf structures and fructifications. The main element of these beds is *Dicroidium*, which provides the basis for dating these beds as Triassic. Even the palynoflora (Tiwari & Ram-Awatar, 1989) suggested a Triassic age for these *Dicroidium* bearing beds.

The fossil plants so far described include members belonging to algae, bryophytes, pteridophytes and gymnosperms. The megafossils of these beds have been described from time to time by Srivastava (1971, 1974, 1975, 1976, 1977), Bose and Srivastava (1970, 1971, 1972, 1973), Srivastava and Maheshwari (1973), Pant and Basu (1973, 1977, 1978, 1979, 1981) and Pant and Pant (1987). The present paper describes a structurally preserved detached synangiate organ frequently encountered among the carbonaceous residues extracted after HF maceration of the shales. The synangia are closely comparable to the pteridospermous pollen organ *Caytonanthus* Harris of the Caytoniales.

GEOLOGY

The Nidpur beds occur in the Gopad River section, western part of Singrauli Coalfield, Sidhi District, Madhya Pradesh, India. The sediments exposed on left bank of Gopad River about 2 km north-east of Nidpur Village (24°7' : 81°53') are found between two faults (F² and F³). The area occurring south of confluence of Sehra Nala with Gopad River have been considered as "Nidpur beds" and area of study termed as "Marhwas area" (24°0' - 24°10' : 81°50' - 82°0') named after Marhwas Village (Tiwari & Ram-Awatar, 1989). The Marhwas area is located in Singrauli Basin and Nidpur beds occupy western most part of the basin. The situation of the basin is such that it occupies a point at the trijunction of Damodar, Satpura and Son-Mahanadi grabens. The country around Marhwas and Nidpur villages is flat alluvial plain exposing the

Triassic sediments in river cuttings. The Nidpur beds along Gopad River cuttings contain carbonaceous compressions preserved on grey coloured, medium grained and micaceous shale (Fig. 1).

MATERIAL AND METHODS

Compressed material of detached pollen organ contained within the Triassic shales was collected from the bank of Gopad River near Nidpur Village, Marhwas area, Sidhi District, Madhya Pradesh, India. Structurally preserved detached pollen organs were extracted by dissolving the rock in HF. The synangia were sorted out under stereo-binocular after the acid (HF) treatment and washing the extracted organic residues of rock. For the study of surface sculptural pattern the dry specimens were mounted in cavity slide and observed under incident unilateral light. But others were subjected to maceration in Schulze's fluid to study their cuticular details and inner contents. Macerated specimens after staining in safranin were mounted in glycerine jelly and examined under transmitted light. Photographs of the pollen organ were taken with a Wild Leitz Microscope. All slides and hand specimens have been deposited in the Divya Darshan Pant collection Museum of Botany Department, Allahabad University, India.

SYSTEMATICS

Pteridospermous Male Fructification

Genus—*NIDIANTHUS* gen. nov.

Diagnosis—Synangia cylindrical to elongate, radially symmetrical, basally attached to short axis or ultimate branchlet and composed of four pollen sacs. Pollen sacs fused at base but appearing attached or free in the middle and apical regions. Individual pollen sacs of synangia with prominent attenuated tips and broadly tapering bases. Surface of pollen sacs longitudinally striated, sacs separating from one another longitudinally along axis of synangium and dehiscing inwards but remaining attached basally. Pollen sac wall cutinized, single layered. Cuticle delicate consisting of elongated, rectangular

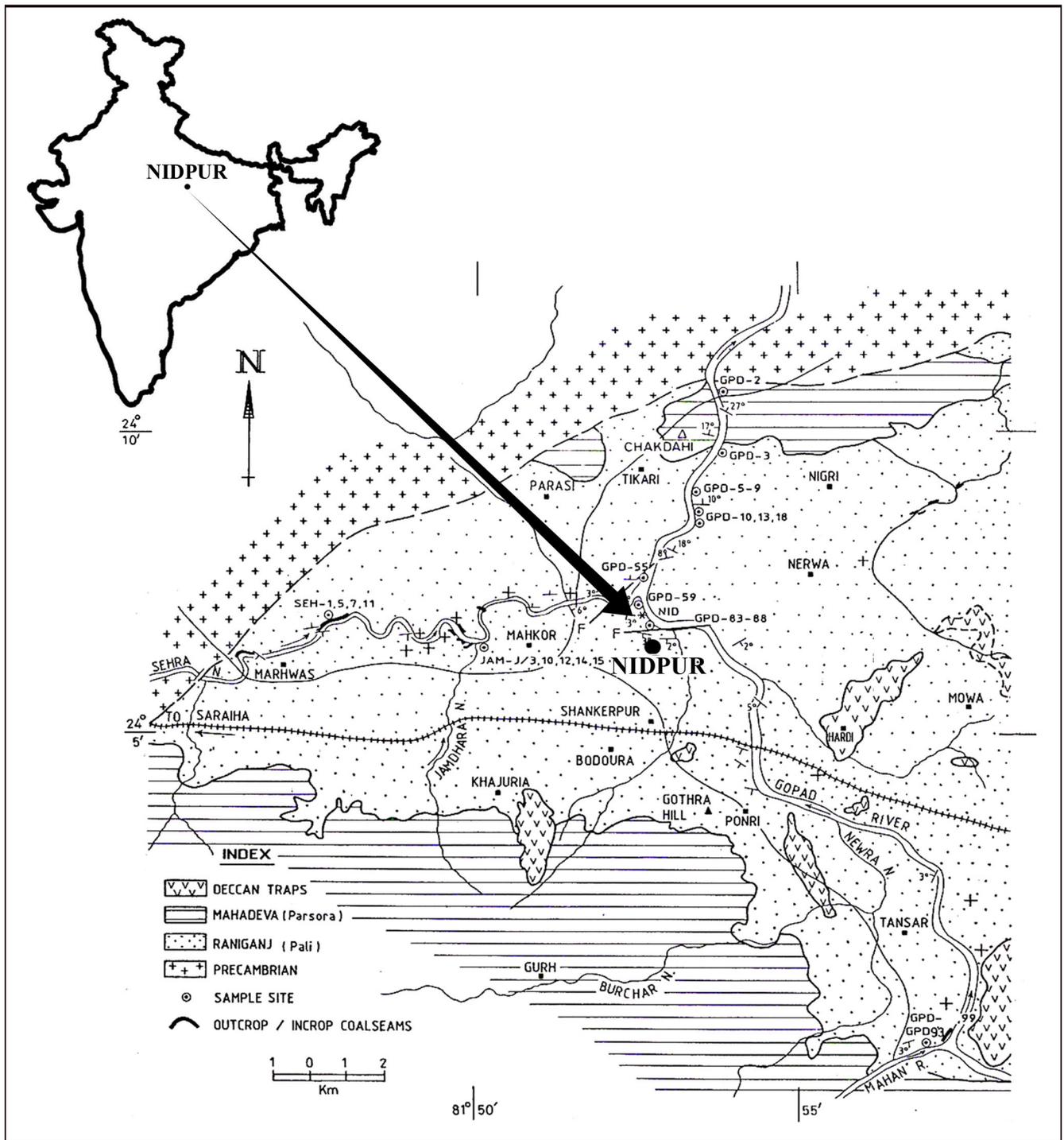


Fig. 1—Geological map of north-west Singrauli Coalfield showing Marhwas area where the Nidpur beds are situated (after Raja Rao, 1983).

to polygonal thin-walled cells. Some cells of pollen sac wall medianly papillate or bearing unicellular hairs near apex. Pollen forming a single pollen mass in each pollen sac. Pollen-grains bisaccate, width of total grain ca. 34 μ m, height of sacci about

2/3rd width of total grain. Corpus almost as wide as high and usually plain or showing faint reticulations. Sacci normally inflated, distally offset, height lesser than corpus and showing reticulate ornamentation.

Type species—*Nidianthus indicus* sp. nov.

NIDIANTHUS INDICUS sp. nov.

(Pls 1-2; Fig. 2A-P)

Diagnosis—Synangium cylindrical to elongated, radially symmetrical, consisting of a short axis or ultimate branchlet basally and composed of four pollen sacs. Synangia 2-4 mm long and 1-1.5 mm broad. Pollen sacs fused at base but appearing free in the middle and apical regions of synangium. Basally attached short axis or ultimate branchlet more or less quadrangular measuring 0.2 mm long \times 0.3 mm wide. Synangia devoid of basal attachment, exhibit a quadrangular abscission scar. Pollen sac wall striated, single layered. Epidermis showing longitudinal striations. Cuticle thin, cells thin-walled, 0.5-2.5 μ m in thickness, elongated, rectangular to polygonal, 18-43 μ m long \times 3-13 μ m wide with straight to slightly meandering cell walls. Some cells medianly papillate. Papillae approximately 20 μ m long \times 10 μ m broad. Apical region showing cells bearing cutinized unicellular papillae or trichomes. Pollen-grains occurring in single pollen mass inside each pollen sac. Pollen-grains bisaccate, averaging 34 μ m wide from wing to wing (ranging from 28-40 μ m), central cell averaging 27 μ m long, sacchi about 22 μ m wide (ranging from 18-25 μ m).

Holotype—Specimen No. 52, 101.

Repository—Divya Darshan Pant collection, Botany Department, University of Allahabad, Allahabad, India.

Horizon—Triassic (Middle Gondwana).

Locality—Nidpur Village, Marhwas area, Sidhi District, Madhya Pradesh, India.

Description—*Nidianthus indicus* gen. et sp. nov. is a synangiate pollen organ represented by more than 30 detached specimens, out of which the holotype No. 52, 101 and some others are preserved with a short axial attachment (Pl. 1-2; Fig. 2D, G), while the rest were without the axial attachment but showed a distinct quadrangular to polygonal abscission scar at base of synangium, indicating the point of attachment of the synangium to the short axis or ultimate branchlet (Pl. 1-4, 5; Fig. 2I, K). The axial attachment is short, radially symmetrical more or less quadrangular in outline, 0.2 mm long \times 0.3 mm wide with faint, longitudinal surface striations. The synangia

appeared to have become detached from axis quite early similar to the condition mentioned in case of *Caytonanthus oncodes* (Harris, 1941) where most of the synangia became detached from microsporophyll long before preservation leaving distinct scars of synangial attachment and only a few remained still attached to axial organ. It is quite possible that synangia of *Nidianthus* were not detached together with axial organ or ultimate branch but became dissociated from branchlet at synangial base. In support of this presumption it may be mentioned that the authors often came across small sterile axes with ultimate branches devoid of any foliage or fruiting bodies in the sieved out HF macerates. The possibility of such axes representing microsporophylls of *Nidianthus* from which all synangia had become detached, leaving the rachis almost naked except the impressions of quadrangular scars or short ultimate branchlet here and there, could not be ruled out, but in the absence of any of these axes bearing even a single synangium prevented us from presently assigning the detached axes to genus *Nidianthus*. The synangia of *Nidianthus* seemed to have been preserved at different stages of dehiscence and dispersal, where in some synangia, all the four pollen sacs seemed to be closely adherent to each other right from base to apex while in others the four pollen sacs seemed to have drawn away from each other along middle region and apex, leaving almost four distinct symmetrical gaps. However, the pollen sacs remained attached to each other at base (Pl. 1-3, 6, 7; Fig. 2C, J). In addition to this the pollen sacs of some synangia were separated only at apex clearly exhibiting their attenuated tips (Pl. 1-8, 9, 10; Fig. 2F, H). Dehiscence of pollen sacs occurred by means of a longitudinal slit along the middle line on its inner face. Inrolling of pollen sac wall along the longitudinal slit after dehiscence possibly caused separation of pollen sacs along the middle.

Each pollen sac of a synangium is cylindrical to elongated in shape with a gradually tapering base and strongly attenuated multicellular tip. Surface of pollen sac showed distinct longitudinal striations from apex to base. In partially macerated specimens, wall of pollen sac appeared thick and opaque showing elongated thick-walled cells, arranged in vertical files but transverse walls were rarely visible (Pl. 2-4; Fig. 2L). However, completely macerated pollen sacs of a synangium yielded a thin cuticle showing narrow elongated, rectangular to polygonal cells over a large part of the wall and

Fig. 2—*Nidianthus indicus* gen. et sp. nov. A, B, E. Showing detached synangia devoid of basal attachment. Each synangium composed of 4 pollen sacs closely appressed to each other. Specimen Nos. 52,103, 52,110, 52 & 111. C, J. Synangia showing different stages of dehiscence with pollen sacs withdrawing from each other in the middle and apical regions but remaining attached at base. Surface of pollen sac showing longitudinal striations. Specimen Nos. 52,105 & 52,102. D, G. Synangium attached to reduced axial organ or ultimate branchlet at base and showing longitudinal surface striations. Specimen Nos. 52,101 & 52,112. I. Synangium showing quadrangular abscission scar at base. Specimen No.52,104. K. Magnified basal portion of synangium in Fig. I showing abscission scar. Specimen No.52,104. F, H. Synangia showing attenuated tips of pollen sacs. Specimen Nos. 52,107 & 52,109. L. Partially macerated pollen sac wall of a synangium showing narrow, rectangularly elongated thick-walled cells of epidermis. Slide No. 52,114. M. Macerated cuticle of pollen sac wall showing cell outlines, papillae bases and apical papillae or trichomes and a few two-winged pollen-grains. Slide No. 52,101. N, O, P. Various compressed two-winged pollen-grains isolated from pollen mass of a pollen sac. Slide No. 52,113.

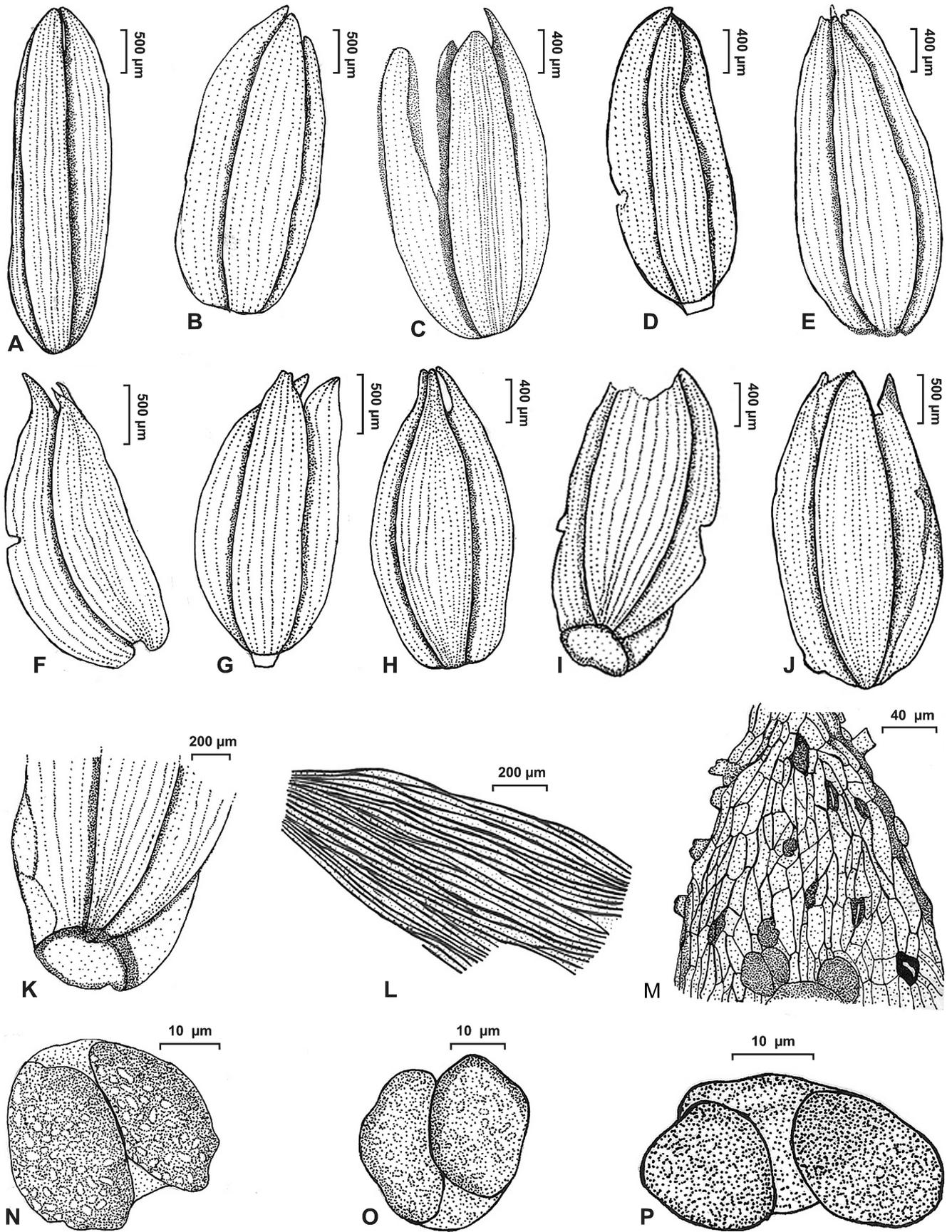


Fig. 2

narrower cells along the inner margin. Anticlinal walls were thin, obscurely straight or slightly sinuous. Some cells of the cuticle showed median papilla bases and in many, the apical region showed cutinized papillae or unicellular hairs in addition to papillae bases (Pl. 2-1, 2, 3, 5; Fig. 2M). Besides outer cuticle, the pollen sac wall in a number of specimens also yielded a second cellular to granular membrane to which were found sticking many two-winged pollen-grains (Pl. 2-6, 7, 8). It is quite possible that the granular layer represented a degenerating tapetum. Inside the pollen sacs are two-winged pollen-grains which are closely adherent to each other forming a large single pollen mass (Pl. 2-9, 10). The two winged pollen-grains of the pollen mass are approximately of the same size but in some of the dehisced pollen sacs which were almost entirely empty there were a few larger sized two-winged pollen-grains found adhering to the inner side of pollen sac cuticle (Pl. 2-1, 2, 3, 5).

Association of larger sized two-winged pollen-grains with pollen-grains of pollen mass in dehisced pollen sac cuticles of *Nidianthus* could have been a chance association as such pollen-grains could well have belonged to other pteridosperms growing in the vicinity of *Nidianthus*. Pollen-grains are bisaccate with more or less hemispherical to obovate sacchi. Height of sacchi lesser than corpus and about 2/3rd width of total grain size. Corpus almost as wide as high and usually plain or showing faint reticulations. Sacchi normally inflated, distally offset, showing reticulate ornamentation. The sulcus appeared as a narrow slit with wavy margin (Pl. 2-11-16; Fig. 2N-P). The pollen-grains of *Nidianthus* resemble the Middle Pennsylvanian *Vesicaspora* to some extent.

COMPARISON AND DISCUSSION

Nidianthus gen. et sp. nov. closely resembles the anther-like pollen organ *Caytonanthus* Harris (Harris, 1941, 1951; Krassilov, 1977) of Caytoniales. The Order showed widespread distribution in northern hemisphere from Upper Triassic to Middle Cretaceous Ages. The new genus resembles *Caytonanthus* Harris in almost all structural features and appears to closely resemble the species, *C. oncodes* described

by Harris (1941) in structure of synangia as well as size of pollen-grains.

Nidianthus is also comparable to *C. tyrmensis* described by Krassilov (1977) from Mesozoic of U.S.S.R. in almost all structural features including the size of synangia which are reportedly larger than those described by Harris (1941).

Until now synangiate organs of *Caytonanthus* type have not been reported from the Indian sub-continent although Bose and Banerji (1984) had reported the occurrence of *Caytonia*-fruit and foliage-*Sagenopteris* of Caytoniales from Bhuj Formation of Kachchh, Gujarat. The "fruits" of *Caytonia indica* were isolated from rock matrix by bulk maceration. Besides *Caytonia*, Bose and Banerji (1984) had also reported from the same beds the occurrence of some microsporophyllous structures which were assigned to a new genus *Kachchhia*. According to them the new genus *Kachchhia navicula* "showed a striking resemblance with species of *Caytonanthus* Harris figured by Harris (1964, Fig. 7A-C)" but differed from it in having bilocular sporangium with two distinct pollen masses. Besides this, *Caytonanthus* appeared quite distinct from *Kachchhia* in being synangiate with four pollen sacs and inside each pollen sac was a single mass of two-winged pollen-grains.

In comparing *Nidianthus* gen. et sp. nov. with *Kachchhia* we found that while the ultimate branch of *Kachchhia* bore bilocular sporangium close to the margin having two elliptic masses of spores, the synangium of *Nidianthus* bore four pollen sacs and within each pollen sacs was a single mass of two-winged pollen-grains. Besides this, the spore mass of *Kachchhia* had been reported to be composed of immature grains whose structure was unknown and only some of the dissected sporangial walls were reported to show a few bisaccate, non-striate grains whose chances of belonging to *Kachchhia* had been doubted by the author's themselves (see Bose & Banerji, 1984).

Nidianthus is also comparable to a synangiate pollen organ *Idanothekion* (Millay & Eggert, 1970) reported from Middle Pennsylvanian of Illinois, in being synangiate and in having two-winged pollen-grains but differed from the same in a number of features. *Idanothekion* was reported as having

PLATE 1

Nidianthus indicus gen. et sp. nov.



1. A radially symmetrical elongated to cylindrical synangium with 4 undehisced pollen sacs closely appressed to each other. Specimen No. 52,103.
2. An undehisced synangium attached to a reduced axial organ or ultimate branchlet. Holotype Specimen No. 52,101.
- 3, 6, 7. Specimens of synangia without axial attachment, showing different stages of dehiscence and withdrawal of 4 pollen sacs in the middle and apical regions while remaining attached at base. Surface of pollen sac wall shows distinct longitudinal striations. Specimen Nos. 52,102, 52,105 & 52,106, respectively.
4. A synangium with longitudinal surface striations and quadrangular abscission scar at base. Apex of synangium partially destroyed showing the tip of only one of the four pollen sacs. Specimen No. 52,104.
5. Basal region of synangium in Fig. 4, further magnified to show quadrangular abscission scar. Specimen no. 52,104.
- 8, 9, 10. Undehisced detached synangia showing attenuated tips of pollen sacs seeming to lie apart. Specimen Nos. 52,107, 52,108 & 52,109 respectively.

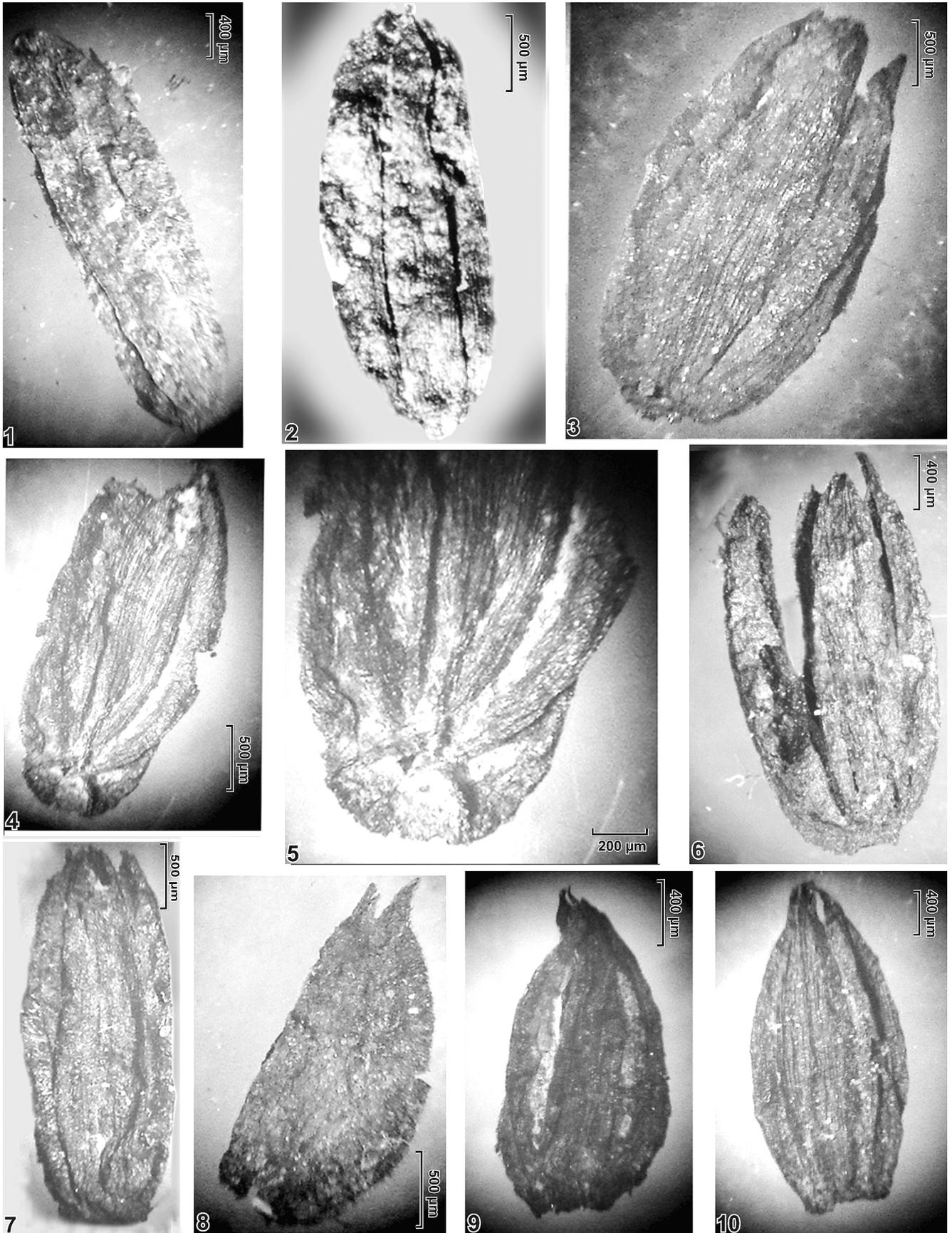


PLATE 1

7-9 sporangia per synangium where sporangia were fused with each other laterally for $4/5^{\text{th}}$ of their length. In addition to this the sporangia were reportedly arranged about and fused to a short central column. On the contrary, synangia of *Nidianthus* consisted of four radially arranged pollen sacs which were closely appressed to each other but fused only in the basal region and there was no central column around which were arranged the four pollen sacs.

Another polleniferous organ remotely comparable to *Nidianthus* is *Permotheca* Zalesky reported from the Late Permian (Tatarian) of Kullarovo Cisuralin Russia. Out of its several recognized species, one species *Permotheca helbyi* has been reported from Early Triassic of southeastern Australia by Retallack (2002). The genus is based on a few splayed clusters of sporangial heads where the sporangia are proximally semisynangiate for about one-third to half their length and pollen sacs are arranged radially in a wide arc from the base of sacs which are fused. The sporangial walls are multilayered and vascularized. The synangia are arranged on short slender stalks to a main axis. The number of sporangia in sporangial clusters showed a wide range of variation from being 6 in *P. disparis* to 15-20 in *P. helbyi*. *Permotheca* resembled *Nidianthus* in being semisynangiate and in having sporangia of about the same size but differed from it in a number of features, viz. *Nidianthus* is based on dispersed cylindrical to elongated synangia where pollen sacs appeared closely adherent for almost their entire length while being fused only at base whereas in *Permotheca* pollen sacs were arranged in a wide arc from base of sacs. The sporangial wall is single layered made up of elongated, rectangular to polygonal cells some of which are medianly papillate but cells of apical region bear unicellular papillae or trichomes. Inside the pollen sacs were single masses of only two-winged pollen-grains, while in case of *Permotheca* both monosaccate-bilobed and bisaccate conditions are met within a single sporangium (Krassilov *et al.*, 1999). Besides, affinities of *Permotheca* are still uncertain and it has been assigned to different plant groups from time to time, while Krassilov *et al.* (1999) found it to be closely related to the Carboniferous callistophytes, Meyen (1987) has assigned such polleniferous organs to family Peltaspermeaceae

as well as family Cardiolepidaceae. Recently on the basis of close association Retallack (2002) has described *P. helbyi* as also being the pollen organ of *Lepidopteris callipteroides* of Pteridospermales. The genus *Nidianthus*, however, is believed to resemble closely *Caytonanthus* Harris of Caytoniales.

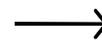
Nidianthus may also be compared with another pollen organ *Perezlaria oaxacensis* described by Delevoryas and Gould (1971) from Middle Jurassic of Oaxaca, Mexico which showed "isolated organs resembling the synangia of *Caytonanthus*". The sporangia of synangia were about 3 mm long and appeared to dehisce as units, similar to the pollen sacs of *Nidianthus*. Besides this, the isolated organs reportedly also appeared in the vicinity of *Glossopteris*-like foliage, since according to Krassilov (1977) there was a striking similarity between *Sagenopteris* leaflet and *Glossopteris*-like leaf and presence of both the elements substantiated presence of Caytoniales in the beds.

It may be mentioned at the outset that in the Nidpur beds too, *Glossopteris* leaves had been reported by Srivastava (1977) and Pant and Pant (1987) and if such leaves were presumed to represent detached leaflets of *Sagenopteris* on account of their close similarity (Krassilov, 1977) then the possibility of Caytoniales occurring in the Triassic beds of Nidpur could not be ruled out.

Regarding distribution, Barrett (2004), believed fossils of Caytoniales first appeared in the Upper Triassic and were widely distributed in the northern hemisphere including Japan, Greenland, Canada and U.S.A. (from where only vegetative material was known). The foliage known as *Sagenopteris*, was palmately compound with 3-6 reticulately veined leaflets. The leaflets of *Sagenopteris* were closely comparable to the leaf fossils of Glossopteridales of the old southern Gondwana continent. This similarity led Crane *et al.* (2004) to suggest the possibility of *Caytonia* having evolved from the Permian glossopterids of the old southern continent Gondwana and at some stage Caytoniales having Pangean or Gondwana ancestors. Even Krassilov (1977), while accepting similarity between *Sagenopteris* leaflets and *Glossopteris* leaf had suggested a glossopteridalean ancestry for Caytoniales.

PLATE 2

Nidianthus indicus gen. et sp. nov.



1. Macerated cuticle of pollen sac wall of a synangium with a few pollen-grains sticking to it. Slide No. 52,101.
2. Cuticle of pollen sac in Fig. 1, further magnified to show cell outlines, papillae bases and apical papillae or trichomes. Slide No. 52,101.
3. Cuticle of pollen sac in Fig. 1, more highly magnified to show presence of two-winged pollen-grains. Slide No. 52,101.
4. Partially macerated pollen sac wall showing narrow, rectangularly elongated cells of epidermis. Slide No. 52,114.
5. Thin cuticle of another pollen sac of same synangium showing profuse papillae bases and two over-sized saccate pollen-grains presumably of foreign origin. Slide No. 52, 101.
6. Portion of granular inner membrane of pollen sac wall. Slide No. 52,101.
- 7, 8. Portions of other granular, inner membranes of pollen sac wall with two-winged pollen-grains sticking to them. Slide No. 52,101.
9. A few closely adhering two-winged pollen-grains teased out of the pollen mass of a pollen sac shown in Fig. 10. Slide No. 52,113.
10. An over macerated pollen sac containing a large, single pollen mass of two-winged pollen-grains of approximately the same size. Slide No. 52,113.
- 11-16. Various compressed two-winged pollen-grains isolated from the pollen mass in Fig. 10. Slide No. 52,113.

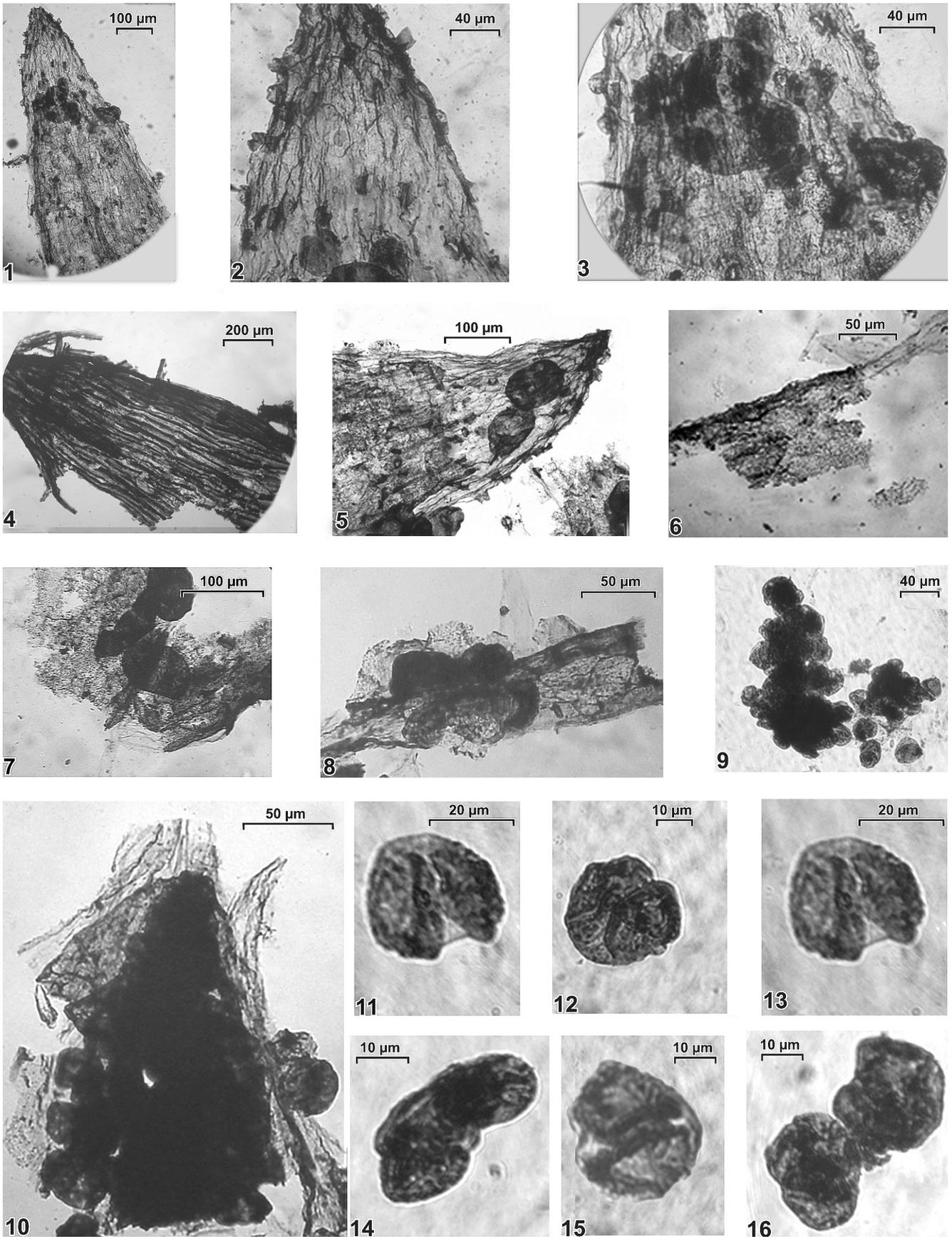


PLATE 2

Thus the report of *Caytonanthus* - like *Nidianthus*, from the Indian Triassic and its association with *Glossopteris* foliage together with reported occurrence of *Caytonia* "fruits" and *Sagenopteris* leaves from fossil flora of Kachchh (Bose & Banerji, 1984) not only indicated the occurrence of *Caytonia* - like plants in the southern hemisphere as well as northern hemisphere but also lent support to the speculation of *Caytonia* having evolved from the Permian glossopterids of the old southern continent Gondwana (Crane *et al.* 2004).

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