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THE FOSSIL FLORAS OF KACHCHH. II — MESOZOIC MEGASPORES

JAYASRI BANERJI, B. N. JANA & HARI K. MAHESHWARI

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

ABSTRACT

Megaspores have been recorded from the Bhuj Formation exposed in Pur River Section near Trambau, Pat River Section near Nangor, Kharod River Section near Gadhsisa, Chawad River Section near Charkhada, Korawadi River Section near Dharesi, Bhuj Formation, Bukhi River Section near Dhinodhar, open pit near Guneri, and 5 shallow wells, 1 each near Madhapur, Kera, Sukhpur, Ugedi and Walka Mota. The new record and a revision of earlier work now reveal a megaspore assemblage comprising 27 species referable to 11 genera. There is hardly any element that could help in fixing a definite age to the sediments. The overall assemblage, however, is indicative of Lower Cretaceous age.

Key-words — Palynology, Megaspores, Bhuj Formation, Lower Cretaceous (India).

सारांश

कच्छ के अश्मित वनस्पतिजात. 2 — मध्यजीवी गुरुबीजाणु — जयश्री बैनर्जी, बृजेन्द्र नाथ जाना एवं हरिकृष्ण माहेश्वरी

ट्राम्बो के निकट पुर नदी अनुभाग, नांगोर के समीप पेॅट नदी अनुभाग, गढ़सीसा के पास खरोड नदी अनुभाग, चरखड़ा के समीप च्वाड़ नदी अनुभाग, धारेसी के पास कोरावड़ी नदी अनुभाग, धीणोधर के समीप बूखी नदी अनुभाग एवं गुनेरी के निकट एक खुले गर्त में विगोपित भुज शैल-समूह तथा पाँच उथले कुओं अर्थात् माधापर, केरा, सुखपर, उगेडी एवं वल्कामोटा के समीपस्थ प्रत्येक कुएँ से प्राप्त गुरुबीजाणुओं का उल्लेख किया गया है। नवीन अभिलेख तथा पिछले शोध-कार्य के पुनरीक्षण से अब यह 11 वंशों से निरूपणीय एवं 27 जातियों वाली समुच्चय व्यक्त होती है। इस समुच्चय से उपलब्ध मुश्किल से ही कोई ऐसा अवयव होगा जो इन अवसादों की आयु सुनिश्चित करने में सहायक सिद्ध हो। तथापि, सम्मिलित रूप से यह समुच्चय अधरि क्रीटेशस आयु की द्योतक है।

INTRODUCTION

IN the past two decades, some very valuable contributions have been made to the investigation of megaspores from the Gondwana sediments of India. All these megaspores, having been obtained by acid breakdown of sediments, are known only in dispersed state. Neither have they been found *in situ* nor are their parent plants known. Of course, their affinities have usually been assumed to be with the Selaginellales. Though the megaspores are fairly well represented throughout the Gondwana Sequence of India, surprisingly, however, there are a very few records of lycopodophytean mega-remains.

Earlier, megaspores were usually described as seen either in dry, opaque state, or in translucent condition. Pant and Srivastava (1964) combined the two, by first documenting and observing the megaspores in dry state and then reducing these to translucent state by progressive maceration and digestion in nitric acid and potassium hydroxide respectively to reveal finer inner structures. Their technique was later followed, with suitable modifications, by Bharadwaj and Tiwari (1970), Maheshwari and Banerji (1975), Banerji, Kumaran and Maheshwari (1978), etc.

As compared to the Lower and Middle Gondwana megaspores, the Upper Gondwana megaspores have received scant attention in recent years. Dev (1961) described a few megaspores from the Jabalpur Formation beds exposed in the Sher River near Sehora (Satpura Gondwana Basin), Narsinghpur District, Madhya Pradesh. Then, Singh, Srivastava and Roy (1964) documented megaspores isolated from the shales of the Bhuj Formation exposed in

Pur River near Trambau and in a Quarry near Guneri, Kachchh District, Gujarat. Both these publications report megaspores as observed in translucent condition only. Elsewhere on the subcontinent megaspores have been reported from the Variegated Shale of Salt Range, Pakistan (Sah & Jain, 1968).

During the period 1976-1982 more than 1500 palynological samples were collected from a score of locations in the Kachchh Mainland Basin. As reported elsewhere in this series, a large number of samples have yielded pollen, microspores and dinoflagellate cysts. Quite a few of the samples have also yielded megaspores which form the subject matter of this paper. The megaspore locations are given below (see also Map 1).

(i) Pur River Section near Trambau (Trambau-Pur),
(ii) Pat River Section near Nangor (Nangor-Pat),
(iii) A water well near Madhapur Petrol Station, Bhuj (Madhapur well),
(iv) A water well 4 kilometers from Kera on Kera-Daisara Road (Kera well),
(v) A water well 10 kilometers west of Bhuj on Bhuj-Nakhatrana Road (Sukhpur well),
(vi) Kharod River Section near Gadhsisa (Gadhsisa-Kharod),
(vii) A water well 6 kilometers north of Ugardi (Ugedi) on Nakhatrana-Lakhpat Road (Ugedi well),
(viii) Bukhi River Section about 0.5 kilometer from Devisar on Devisar-Bhimsar Road (Devisar-Bhuki),
(ix) Chawad River Section near Dhamae-Charkhada Road crossing (Dhamae-Chawad),
(x) A water well 1 kilometer east of Walka Mota (Walka Mota well),
(xi) Open cast coal mine about 0.5 kilometer south-west of Guneri Village (Guneri Mine), and
(xii) Korawadi River Section about 2 kilometer west of Dharesi Village (Dharesi-Korawadi).

Each megaspore was first photographed in dry state under reflected light and its characters were noted. For photography, the megaspore was transferred to a clean glass slide, placed on the stage of an AMPLIVAL microscope, illuminated by two ordinary table lamps, one with a 100 W filament bulb and the other with a 60 W filament bulb. The background was made white by placing a piece of unglazed white paper on the condenser and lifting the latter up. ORWO NP 15 or AGFAORTHO 25 film was used. After photographing in dry state, the megaspore was transferred to a covered petridish and was oxidised with nitric acid, sometimes using potassium chlorate. The oxidised material was digested with potassium hydroxide and cleaned with water. Observations were made at frequent intervals during this progressive maceration and photographs were taken, as and when felt necessary, by transmitted light using the same microscope and films. Thus, the megaspores, though documented in both dry and wet states, are now available only as translucent structures. Due to the technique adopted for investigation, their types have to be the illustrations. Megaspores reported by Singh, Srivastava and Roy (1964) have also been reinvestigated and included in this paper. SEM photomicrographhs were taken for us by Dr Usha Bajpai on Jeol 35C.

DESCRIPTION

Anteturma — *Sporites* Potonié, 1893

Turma — *Triletes* Reinsch emend. Potonié & Kremp, 1954

Subturma — *Azonotriletes* Luber, 1935

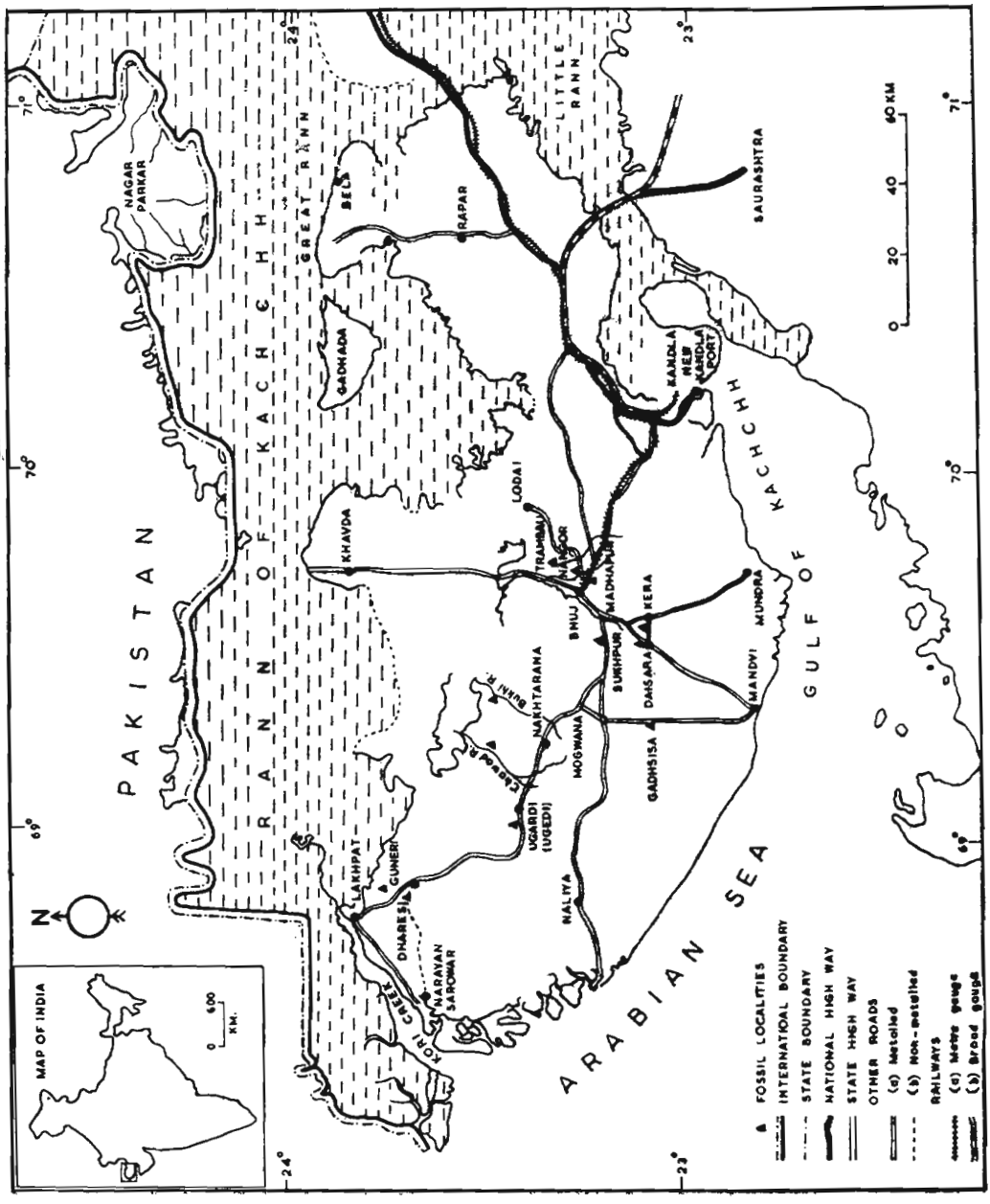
Infraturma — *Laevigati* Bennie & Kidston emend. Potonié, 1956

Genus — *Banksisporites* Dettmann, 1961 emend. Banerji, Kumaran & Maheshwari, 1978

1970 *Srivastavaesporites* Bharadwaj & Tiwari, *Palaeontographica*, **B129**: 22.

Type species — *Banksisporites* (*Triletes*) *pinguis* (Harris, 1935) Dettmann, 1961.

Diagnosis (*as in Banerji et al., 1978, p.* 3) — "Megaspores subcircular to subtriangular, trilete. Trilete laesurae distinct, straight to sinuous with lips; curvaturae ill-defined to distinct. Exosporium smooth to granulate, mesosporium indistinct to well-defined, thin, usually covering more than half radius of spore cavity, without cushions",


PAKISTAN
RANN OF KACHCHH
GREAT RANN
LITTLE RANN
KACHCHH
GULF OF
ARABIAN SEA
SAURASHTRA
NAGAR PARKAR
BELA
RAPAR
GADHADA
KHAVDA
LODAI
TRAMBAU
NAKHTARANA
BHUJ
MADHAPAR
SUKHPUR
KERA
DAISARA
MUNDRA
MANDVI
GADHSISA
MOGWANA
MALIYA
UGARDI (UGEDI)
GUNERI
LAKHPAT
DHAREŚI
NARAYAN SAROWAR
KORI CREEK
KANDLA
NEW KANDLA PORT
MAP OF INDIA
N
0 20 40 60 KM
0 600 KM.
FOSSIL LOCALITIES
INTERNATIONAL BOUNDARY
STATE BOUNDARY
NATIONAL HIGH WAY
STATE HIGH WAY
OTHER ROADS
(a) Metalled
(b) Non-metalled
RAILWAYS
(a) Metre gauge
(b) Broad gauge

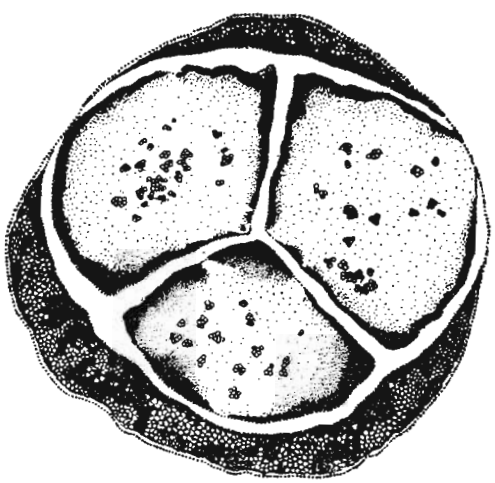
MAP 1

Remarks — Megaspores of *Banksisporites* type are virtually indistinguishable in surface features from those of the genus *Trileites* Erdtman, 1947 ex Potonié, 1956. Dettmann (1961, pp. 74, 75) distinguished the latter supposing it to be acavate. Fuglewicz (1973), on the authority of Fitting (1900) and Potonié (1966), states that genera of megaspores should not be erected on the basis of inner structures. However, in Gondwana megaspores at least, it has been conclusively shown that inner structure is of great value in demarcating not only species but also genera (Hφeg, Bose & Manum, 1955; Dettmann, 1961; Pant & Srivastava, 1961, 1962; Bharadwaj & Tiwari, 1970; Maheshwari & Banerji, 1975; Banerji Kumaran & Maheshwari, 1978, etc.).

Banksisporites kachchhensis sp. nov.

Pl. 1, figs 1-7; Text-fig. 1

Diagnosis — Megaspores circular in shape, occasionally subcircular; contact areas well-defined, with a caved-in appearance, delimited by near-peripheral arcuate ridges and straight or slightly wavy near trijunction, triradiate ridges. Exosporium scabrate to coarse granulate, usually in-folded along the curvaturae; mesosporium inconspicuous filling almost the entire spore cavity.



TEXT-FIG. 1 — *Banksisporites kachchhensis* sp. nov.— Megaspore in dry condition showing more or less circular shape and well-developed arcuate ridges, × 100.

Dimensions — Equatorial diameter-dry: 850-1000 μm, wet: 900-1400 μm; Arcuate ridges: 20-50 μm wide; triradiate ridges: 30-40 μm wide as well as high; exosporium: 20-30 μm thick.

Comparison — *Banksisporites tenuis* (Dijkstra, 1955) Dettmann, 1961 is similar in shape, size and exospore ornament but lacks the exospore infolds. *B. sinuosus* Dettmann, 1961 is smaller in size and possesses characteristic sinuous triradiate ridges.

Holotype — Pl. 1, figs 1, 2, slide no. BSIP 8174; Lower Cretaceous, Bhuj Formation, Lower Member, Korawadi River Section near Dharesi Village, Kachchh District.

Occurrence — Kera well; Sukhpur well; Gadhsisa-Kharod; Ugedi well; Walka Mota well; Dharesi-Korawadi.

Turma — *Barbates* Mädler, 1954

Genus — *Hughesisporites* Potonié, 1956

Type species — *Hughesisporites* (*Triletes*) *galericulatus* (Dijkstra, 1951) Potonié, 1956.

Diagnosis (*translated from Potonié, 1956, p. 71*) — Megaspores trilete, exine smooth, in type species Y-rays ± reach equator, equator as well as meridian ± circular. Curvaturae weak, narrow or undeveloped. Contact areas in angles of tecta ionthus with verrucae or spines.

Hughesisporites rajnathii sp. nov.

Pl. 2, fig. 7; Pl. 3, fig. 1

Diagnosis — Megaspore more or less circular in equatorial view; triradiate mark distinct, raised, fairly sinuous, extending for 2/3 of the spore radius; exosporium distinctly ridged near contact area, covering almost 3/4 of spore body area, exinal ridges also sinuous, in acid-processed specimen the ridges of exosporium transforming into wavy, finger-like processes interwoven with each other at the top.

Dimensions — Equatorial diameter, dry: 680 μm, wet: 715 μm.

Comparison — The new species resembles *Hughesisporites variabilis* Dettmann, 1961 in shape and apparent similarity in the ridges near the contact area, but the former can be distinguished from the latter by its bigger size, apparent absence of meso-

sporium and by the characteristic exinal ridges.

Holotype — Pl. 2, fig. 7, slide no. BSIP 8181; Lower Cretaceous, Bhuj Formation, Lower Member, a shallow well about 10 kilometers from Bhuj on Bhuj-Lakhpat Road.

Occurrence — Sukhpur well; Ugedi well.

Derivation of name — After Professor Raj Nath, one of the foremost palaeontologists of the country.

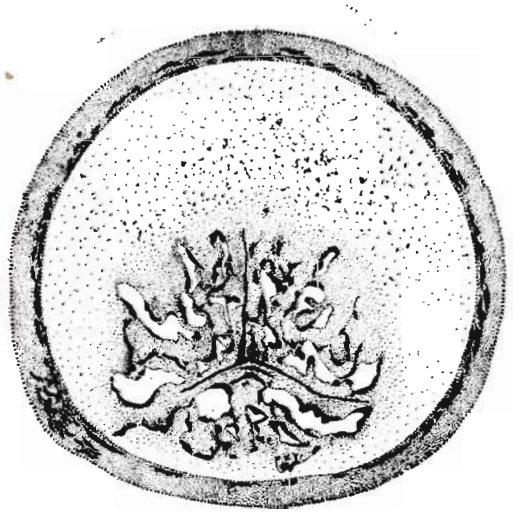
Hughesisporites singhii sp. nov.

Pl. 2, figs 1, 2, 8; Text-fig. 2

Diagnosis — Megaspores circular in shape, subcircular when preserved in slight oblique plane; outer limits of contact areas not delimited by recognisable arcuate ridges, probably coincide with extent of triradiate ridges, latter ± 2/3 of spore radius in length. Exosporium psilate-scabrate, having a number of irregular shaped projections in contact areas, apices of projections directed towards trijunction; mesosporium inconspicuous, filling entire spore cavity.

Dimensions — Equatorial diameter, dry: 350-480 μm, wet: 450-800 μm; exosporium: 35-40 μm thick.

Comparison — These megaspores compare farely well with the Rhaetic species *Hughesisporites ionthus* Harris, 1935. According to Potonié (1956, p. 71) the curvaturae are narrow but recognisable in this species. However, Harris (1935, p. 166, text-fig. 52E-G) illustrates stong curvaturae. *H. ionthus* further differs in having an identifiable mesosporium (Harris, 1935, pl. 26, fig. 8) and in having relatively higher projections in the contact areas. *H. variabilis* Dettmann, 1961 and *H. pustulatus* Marcinkiewicz, 1962 differ in having a distinct mesosporium. *C. patagonicus* Archangelsky, 1965 is much larger in size whereas *H. tumulosus* Marcinkiewicz, 1976 has characterirtig swellings at the ends of triradiate ridges.



TEXT-FIG. 2 — *Hughesisporites singhii* sp. nov.— Megaspore in macerated condition showing well-developed ridges near contact area, × 100.

Holotype — Pl. 2, figs 2, 8, slide no. BSIP 8179; Lower Cretaceous, Bhuj Formation, Lower Member, grab sample from a 30 m deep tube well near Madhapur Petrol Station, 4 km east of Bhuj, Kachchh District.

Occurrence — Trambau-Pur; Madhapur well; Sukhpur well.

Derivation of name — After Dr H. P. Singh, one of the co-authors of Singh, Srivastava and Roy (1964) paper.

Hughesisporites sp.

1964 *Trileites* sp. B: Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 286, pl. 2, fig. 22.

1964 cf. *H. variabilis* Dettmann: *Palaeobotanist*, **12** (3), p. 286 (foot-note).

1964 *Horstisporites* cf. *reticuliferus* (Dijk.) Pot. 1956: *Palaeobotanist*, **12** (3), p. 288, pl. 3, fig. 37.

Description — Trilete megaspores, almost circular to equatorial in diameter. Trilete rays 2/3-3/4 spore radius long, straight to wavy, limited by arcuate ridges. Proximal inter-ray face ornamented with radially arranged, undulating thickenings.

Dimension — Overall size: 840-940 μm in equatorial diameter; exosporium: 20-30 μm thick.

Occurrence — Trambau-Pur; Guneri Mine.

Infraturma — *Apiculati* Bennie & Kidston emend. Potonié, 1956

Genus — *Verrutriletes* van der Hammen, 1954 ex Potonié, 1956

Type species — *Verrutriletes* (*Triletes*) *compositipunctatus* (Dijkstra, 1949) Potonié, 1956.

Remarks — The generic name *Verrutriletes* as proposed by van der Hammen (1954, p. 14) was a nomen nudum. It was validated and legitimised by Potonié (1956, p. 28, pl. 3, figs 24-26) by designating a type species. Potonié (1956) circumscribed the genus as follows:

Holotype *ca* 350 μm (from illustration). Trilete megaspores, equator and meridian more or less circular to subtriangular, Y-rays do not reach equator. Curvaturae not recognisable. Exine sculptured with semicircular warts to low coni of varying size. Contact areas unsculptured (e.g., *carbunculus*) or covered with smaller verrucae or coni (e.g., *dubius*).

Potonié included seven species under this genus. Later on some more species were placed under this genus. Of these, the taxonomic status of *Verrutriletes* (*Triletes*) *carbunculus* (Dijkstra, 1949) Potonié, 1956 has become controversial with possibility that the "hemispherical red translucent 5-30 μ broad objects" ornamenting the surface of the megaspore may not really be the exospore sculputre but may represent "saprophytic organisms" (Pl. 2, fig. 6).

From Potonié's description of *V. carbunculus* it is apparent that he realised the distinctiveness of exospore ornament of this species. According to him (Potonié, 1956, p. 28) the carbuncles are irregularly scattered on the pale exine like frozen, circular, glossy, transparent drops of resin-like liquid. It is noticeable that they occur in groups which leave assymetrical interspaces and that they vary very much in size. He placed this species under *Verrutriletes* only provisionally. Dijkstra (1949, p. 22), too, has not called these objects as verrucae or warts but referred that "the red translucent objects on its wall have a great resemblance to rubies". Similar type of objects have also been reported on *Triletes imitatus* Dijkstra (1959, p. 12, pl. 1, figs 1a-b, 2) and *Trileites murrayi* (Harris, 1961) Marcinkiewicz, 1971 (see Marcinkiewicz, 1979, p. 124, pls 1-7; Marcinkiewicz, 1980, p. 50, pls 3, 4).

Marcinkiewicz (1969) subjected these "spherules" to scanning electron microscopy. Her observations "led to the conclusion that the shape of spherules and their manner of distribution and attachment to the spore exine indicates saprophytic organisms". She named these spherules as *Reymanella globosa*.

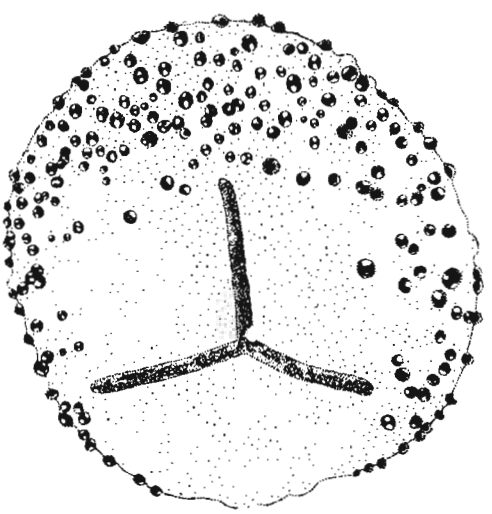
We have a very large number of megaspores having similar type of spherules. These have been recovered from a few samples of Korawadi River Section near Dharesi, and a well-cutting near Walka Mota. If we were to take into account the distribution of the "carbuncles" or the "spherules", these megaspores would have been referred to at least three species, viz.,

(i) *Triletes imitatus* (pl. 2, fig. 5; Text-fig. 3) — Spherules 20-30 μm in length and width, distally densely set, more or less equal in size, proximally absent in contact areas.

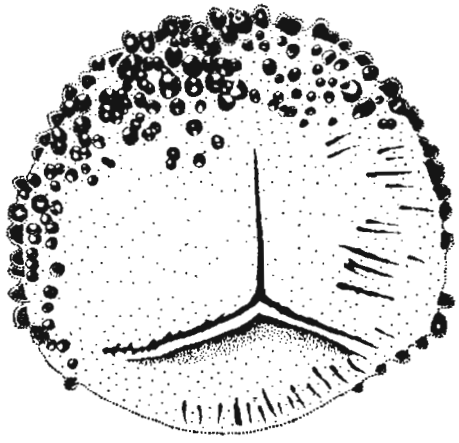
(ii) *New species* (Pl. 2, figs 3, 4; Text-fig. 4) — Spherules present along both proximal and distal equator, rest of proximal and distal exosporium laevigate.

(iii) *Verrutriletes carbunculus* (Pl. 3, fig. 2; Pl. 13, figs 5, 6; Text-fig. 5) — Spherules usually confined to distal surface, but sometimes present over triradiate ridges.

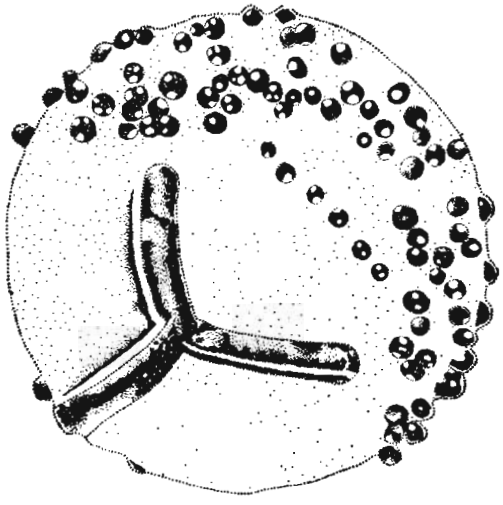
All these megaspores are very dark in colour, almost black and have a lustre. The spherules dissolve in acid without leaving a trace on the exosporium thus supporting Marcinkiewicz's conclusion that the spherules are not elements of sculpture.



TEXT-FIG. 3 — *Triletes imitatus* Dijkstra — Megaspore in dry condition showing more or less laevigate proximal side and well-developed spherules on the distal side, × 75.



TEXT-FIG. 4 — *Verrutriletes* type megaspore — A megaspore in dry condition showing equatorial distribution of spherules, × 75.



TEXT-FIG. 5 — *Triletes carbunculus* Dijkstra type megaspore — Megaspore in dry condition showing well-developed trilete lamellae on proximal side and globular spherules on distal side, × 75.

The distribution pattern of spherules also does seem to have any taxonomic significance. The Kachchh specimens possibly represent *Banksisporites kachchhensis* and related species.

Dimensions of these megaspores are: dry — 800-1200 μm, wet-1000-1800 μm; mesosporium — 1000-1020 μm; spherules 10-40 μm in diameter.

Verrutriletes royii sp. nov.

Pl. 3, figs 5-8; Pl. 5, fig. 6

Diagnosis — Megaspores subtriangular; triradiate ridges distinct, raised, reaching almost up to spore radius, curvaturae absent. Exosporium verrucate, verrucae low, not projecting much at equator, densely packed, uniformly distributed, forming negative reticulum in differentially macerated specimens. Mesosporium not distinct, apparently occupying 2/3 of spore cavity.

Dimensions — Equatorial diameter — dry: 350-450 μm, wet: 500-600 μm; exosporium: 20-30 μm thick, verrucae 8-20 μm at base; Trilete lamellae: 20-45 μm broad, 30-40 μm high; mesosporium: 300-350 μm in diameter.

Comparison — Singh, Srivastava and Roy (1964, p. 286, pl. 2, fig. 25) described a specimen from Trambau as *Verrutriletes* sp. A. The specimen was not illustrated in dry condition. The mounted specimen is not available for study as the slide (no. 1729) purportedly containing this megaspore contains a shrivelled and dry megaspore. *V. obscurus* (Maheshwari & Banerji) Banerji *et al.*, 1978, *V. distinctus* Maheshwari & Banerji, 1975 and *V. minuticorpus* Banerji *et al.*, 1978, all from Triassic of India, differ from the new species, both in overall shape and nature of sculptural elements.

Holotype — Pl. 3, figs 6-8, slide no. BSIP 8185; Lower Cretaceous, Bhuj Formation, Lower Member, Korawadi River Section near Dharesi, Kachchh District.

Occurrence — Sukhpur well; Dharesi-Korawadi.

Derivation of name — After Professor S. K. Roy, one of the co-authors of Singh, Srivastava and Roy (1964) paper.

Verrutriletes stoliczkae sp. nov.

Pl. 13, figs 1, 2

Diagnosis — Megaspore subtriangular, triradiate ridges distinct, raised, wide, extending for 3/4 of spore radius; exosporium verrucate, verrucae crowded on both proximal and distal sides, more or less uniformly distributed; mesosporium indistinct; endosporium clearly discernible in the macerated specimen, subtriangular in shape.

Dimensions — Equatorial diameter-dry: 410 μm, wet: 540 μm; thickness of exosporium: 20 μm; width of triradiate ridge: 50 μm; diameter of mesosporium: 480 μm; diameter of endosporium: 390 μm.

Comparison — The present species closely resembles *Verrutriletes royii* sp. nov. in shape and nature of ornamentation but the former can readily be distinguished from the latter in having three-layered spore body and verrucae projecting uniformly at the equatorial margin.

Holotype — Pl. 13, figs 1, 2, slide no. BSIP 8212; Lower Cretaceous, Bhuj Formation, Lower Member, Shallow water well 10 km from Bhuj on Bhuj-Lakhpat Road.

Derivation of name — After G. Stoliczka who provided the first acceptable classification of Mesozoic sedimentaries of the Kachchh Basin.

Verrutriletes triangulatus sp. nov.

Pl. 3, figs 3, 4; Pl. 5, fig. 1

Diagnosis — Megaspores triangular-subtriangular in shape, triradiate ridges thick, raised, ±4/5 spore radius long. Exosporium verrucate, verrucae low, not projecting beyond equator, densely and uniformly distributed, forming a negative reticulum. Mesosporium distinct, triangular to subtriangular in shape, granulate in texture.

Dimensions — Equatorial diameter — dry: 300-500 μm, wet: 450-700 μm; exosporium 20-25 μm thick, verrucae 10-36 μm at base; trilete lamellae 30-40 μm broad and as much high; mesosporium 310-360 μm.

Comparison — *Verrutriletes triangulatus* is comparable with *V. royii* in overall shape and verrucate pattern of ornamentation comprising low, uniformly and closely distributed verrucae. However, the mesosporium in the former is smaller in size, distinct and triangular in shape. Further, the triradiate ridge ends are characteristically funnel-shaped.

Holotype — Pl. 5, fig. 1, slide no. BSIP 8188; Lower Cretaceous, Bhuj Formation, Lower Member, Korawadi River Section near Dharesi, Kachchh District.

Occurrence — Trambau-Pur; Dharesi-Korawadi.

Verrutriletes sp.

Pl. 7, fig. 7; Pl. 9, fig. 4

Description — Megaspores subcircular, trilete laesurae-half radius long, 20 μm broad, 25-30 μm high; contact area ill-defined. Exosporium about 30 μm thick, verrucose, verrucae except in the contact area uniformly distributed; in the contact area verrucae slightly less developed, at times verrucae bases giving an appearance of pseudoreticulate pattern, mesosporium indistinct.

Dimension — Equatorial diameter — dry: 360-420 μm, wet: 510-570 μm; exosporium 30 μm thick; triradiate lamellae 20 μm broad, 25-30 μm high.

Comparison — *Verrutriletes compositi-punctatus* (Dijkstra, 1949) Potonié, 1956 is comparable in distribution of sculpture elements but differs in having more conspicuous triradiate ridges.

Occurrence — Dharesi-Korawadi.

Genus — *Bacutriletes* van der Hammen, 1954 ex Potonié, 1956

Type species — *Bacutriletes* (*Selaginellites*) *greenlandicus* (Miner, 1932) Potonié, 1956.

Remarks — The genus *Bacutriletes* as published by van der Hammen (1954, p. 14) was a nomen nudum in the absence of a type species. Potonié (1956, p. 35) assigned *Triletes tylotus* Harris, 1935 as the type species and validated the genus. While assigning the type species, Potonié probably overlooked Harris' (1935, p. 163) admission that *T. tylotus* resembles certain specimens of *Selaginellites greenlandicus*, Miner, 1932 except for somewhat overall small size and shorter triradiate ridges. However, these are minor variations if seen in the light of studies on megaspores of extant *Isoetes* (Pfeiffer, 1922) and *Selaginella* (Mitchell, 1910). Therefore, we suggest that *S. greenlandicus* (*T. tylotus*) be the type species of this genus. Potonié circumscribed the genus as "Megaspore genus. Type specimen about 400 μm without bacula (as measured from figure), trilete, circular, tecta of Y-rays strongly developed, 1/3-1/2 spore radius long. Curvaturae of contact areas not decipherable. Exine beset

all over with transversely truncated bacula, which may look worm-shaped".

So far about a dozen species of this genus have been reported and not all have transversely truncated bacula, e.g. *Bacutriletes arnoldii* (Miner, 1932) Potonié 1956, *B. cutchensis* Singh, Srivastava & Roy, 1964 *B. corynactis* (Harris, 1961) Marcinkiewicz, 1971, *P. spicatus* Marcinkiewicz (1962) 1971, etc. In some species, e.g. *B. dijkstrae* Singh, Srivastava & Roy, 1964, the ornamentation may be confined to one face only. *Echitriletes* van der Hammen, 1954 ex Potonié, 1956 is a closely comparable genus, though should be easily distinguished by its capillate-spinate ornamentation.

Emended Diagnosis — Megaspore circular subcircular, trilete, curvaturae not seen, outer limits of contact areas not delimited. Exine baculate, baculae robust or slender, with rounded or transversely truncated ends, distributed on all sides or only on one side and part of other side.

Bacutriletes cutchensis Singh, Srivastava & Roy, 1964

Pl. 4, figs 1, 2

1964 *Bacutriletes cutchensis* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 287, pl. 2, figs 31-33.

Diagnosis (restated from Singh, Srivastava & Roy 1964, p. 287) — Shape circular, triradiate ridges thick, extending ± up to 3/4 spore radius, bacula slender, 4-5 times as long as broad, with rounded apices.

Dimensions — Equatorial diameter in glycerine jelly: 600-1025 μm; exosporium: 10-27 μm thick, bacula/papillae: 30-60 μm long, 6-13 μm broad.

Holotype — BSIP slide no. 1717; Lower Cretaceous, Bhuj Formation, Guneri Member, carbonaceous shale underlying the coal seam in a quarry south-west of Guneri Village, Kachchh District.

Description of Kachchh Specimens — The megaspores are circular in shape with a distinct trilete, rays extending for about 1/2 spore radius. In acid macerated specimens the labra are 10-12 μm broad and commissures are distinct. Exosporium is baculate, bacula closely and uniformly distributed, but absent on a major portion of distal surface.

Dimensions — Equatorial diameter in dry condition: 800-900 μm, in glycerine jelly: 900-1200 μm; exosporium: 10 μm thick, bacula: 20-60 μm long, 10-25 μm broad.

Comparison — The bacula in the type species *B. greenlandicus* are much more robust and transversely truncated. In *B. arnoldii* (Miner, 1932) Potonié, 1956 the bacula are vermiform and the triradiate mark is just a line. The new specimen illustrated here differs from the holotype in the apparent lack of bacula on a part of distal surface.

Occurrence — Kera Well; Walka Mota well; Guneri Mine; Dharesi-Korawadi.

Bacutriletes dijkstrae Singh, Srivastava & Roy, 1964

Pl. 5, figs 2-5

1964 *Bacutriletes dijkstrae* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 287, pl. 3, figs 34, 35.

Diagnosis (restated from Singh, Srivastava & Roy, 1964, p. 287) — Shape ± circular, triradiate ridges ±1/2 spore radius long, gradually tapering away from trijunction, bacula absent on a distal central area having a radius 2/3 of spore radius, bacula 3-5 times as long as broad, with rounded apices.

Dimensions — Equatorial diameter in glycerine jelly: 720-760 μm; exosporium: 12-20 μm thick; bacula: 30-60 μm long, 10-12 μm broad.

Comparison — The absence of the baculate ornamentation on the distal central region distinguishes this species from others.

Lectotype — BSIP slide no. 1722; Lower Cretaceous, Bhuj Formation, Guneri Member, carbonaceous shale underlying the coal seam in a quarry south-west of Guneri Village, Kachchh District. Singh, Srivastava and Roy (1964, p. 287) designated a specimen illustrated as figure 34 on plate 3 as the holotype. It is supposed to be located on slide no. 1722. However, we have not been able to locate this specimen either on slide no. 1722 or on any other slide submitted by them to the Museum of Birbal Sahni Institute of Palaeobotany. The other specimen (*Isotype*) figured by them (1964, pl. 3, fig. 35) is also not traceable. However, slide no. 1722 does contain a megaspore which corresponds to the diagnosis of *Bacutriletes dijkstrae*. This specimen figured here (Pl. 5, fig. 5)

is designated as the *Lectotype* as it forms a part of the original material which was definitely studied by the authors before publication of the name (ICBN, Art. 7.5).

Occurrence — Guneri Mine; Dharesi-Korawadi.

Bacutriletes srivastavae sp. nov.

Pl. 4, figs 3-6

Diagnosis — Megaspores subcircular in shape, triradiate ridges prominent, extending up to one half spore radius in length, commissures distinct, lips 30-40 μm wide. Exosporium baculate, bacula closely distributed but not confluent at base, ± equal in length, rod-like, with rounded apices. Mesosporium very faintly visible, filling almost all the spore cavity.

Dimensions — Equatorial diameter — dry: 700-750 μm, wet: 1100-1250 μm; exosporium: 30 μm thick, bacula: 20-50 μm long, 15-25 μm broad.

Comparison — In overall shape and symmetry the illustrated specimen compares with the holotype figure of *Bacutriletes cutchensis* Singh, Srivastava & Roy, 1964. However, the bacula in *B. cutchensis* are comparatively slender and very closely placed, almost forming a negative reticulum in surface view. The bacula in *B. srivastavae* on the other hand are robust and discrete. *B. dijkstrae* Singh, Srivastava & Roy, 1964 too differs in having "vermiform" bacula.

Holotype — Pl. 4, figs 3-5, slide no. BSIP 8187; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau, Kachchh District.

Occurrence — Trambau-Pur; Kera Well; Walka Mota Well.

Derivation of name — After Dr S. K. Srivastava, one of the co-authors of Singh, Srivastava and Roy (1964) paper.

Infraturma — *Muronati* Potonié & Kremp, 1954

Genus — *Horstisporites* Potonié, 1956

Type species — *Horstisporites* (*Triletes*) *reticuliferus* (Dijkstra, 1951) Potonié, 1956.

Diagnosis (*translated from Potonié, 1956, p. 45*) — Trilete megaspores, equatorial contour circular to slightly subtriangular, Y-rays more or less one half spore radius long, may also be longer, curvaturae not at all or imperceptibly recognisable. Exosporium alveolar to reticulate.

Remarks — The nature of the muri is an important character in distinguishing different species of the genus. For example, in the type species the muri are recognizable only as interspaces between shallow irregularly bordered depressions. In *H. rexargenteus* (Harris, 1935) Potonié, 1956, the muri are very distinct. *H. harrisii* (Murray, 1939) Potonié, 1956 has raised muri which sometimes end freely, i.e. the reticulum is not always perfect. *H. imperfectus* Reinhardt, 1969 also has an imperfect reticulum.

Horstisporites areolatus (Harris, 1935) Potonié, 1956

Pl. 6, figs 1, 2; Pl. 7, fig. 1

1935 *Triletes areolatus* Harris, *Meddr. Grønland*, **12** (1), p. 158, pl. 26, figs 3, 10; text-fig. 51A-F; Rhaetic, Scoresby Sound, Greenland.

1956 *Horstisporites* (*al. Triletes*) *areolatus* (Harris, 1935) Potonié, *Beih. geol. Jb.*, **23**, p. 45.

Diagnosis (*restated from Harris, 1935, p. 159*) — "Almost spherical megaspore, varying in diameter from 600 to 1400 μ, wall not particularly hard, 15-30 μ, not separable into two layers by maceration. Tri-radiate lamellae fairly conspicuous, up to 30 μ wide, projecting about 15 μ; their length being 0.5-0.7 of the radius of the spore. Arcuate lamellae absent but occasionally the pits in the wall are so arranged as to give a slight suggestion of a lower border to the 'facets', but in most cases 'facets' entirely undistinguished. Surface of spore marked with more of less conspicuous round or polygonal pits about 30 μ wide and up to 7 μ deep and separated from adjacent pits by about 5 μ. Substance of wall showing a fine granular structure".

Holotype — Slide no. 4120, *Thaumatopteris* zone, Liassic.

Description of Kachchh Specimen — Megaspore subcircular in equatorial contour, trilete; triradiate ridges distinct, almost one half of spore radius in length, uniformly

broad; curvaturae not seen. Exosporium uniformly reticulate, lumina polygonal or rounded. Mesosporium not seen.

Dimensions — Equatorial diameter — dry: 520-1000 μm, wet: 1113 μm; lumina 15-30 μm, muri 7-15 μm.

Occurrence — Ugedi well; Dhamae-Chawad; Dharesi-Korawadi.

Remarks — The species is probably represented by another megaspore which is comparatively large in size (1470) μm and has broader meshes (20-50 μm). The mesosporium is indistinct.

Horstisporites sp. cf. *H. semireticulatus* Jung, 1960

Pl. 6, fig. 5

1960 *Horstisporites semireticulatus* Jung, *Palaeontographica*, **B107**, p. 142, pl. 38, figs 31-38, Rhaeto-Liassic, Franconia.

Diagnosis (*translated from Jung, 1960, p. 143*) — Trilete megaspores. Equatorial contour circular. Diameter across equator 450-670 μm (in holotype 524 μm). Sculpture of more or less large-meshed, irregular extrareticulum. Equator shows 30-40 lumina. Triradiate ridges 0.6-0.9 spore radius long. Curvaturae indistinct.

Description of Kachchh Specimens — Megaspores ?trilete, subtriangular to circular in equatorial contour. Exosporium with broad-meshed reticulum.

Dimensions — Equatorial diameter — dry: 1110-1200 μm, wet: 1200-1360 μm; lumina 50-80 μm, muri 15-25 μm.

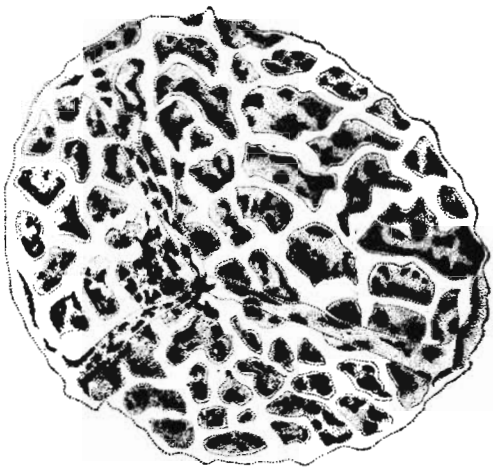
Comparison — Though the exosporium reticulation of the megaspores resembles that of *Horstisporites semireticulatus* Jung, 1960, the overall size of the megaspores is comparatively big.

Occurrence — Trambau-Pur.

Horstisporites biswasii sp. nov.

Pl. 6, figs 6, 7; Pl. 7, fig. 2; Text-fig. 6

Diagnosis — Megaspores trilete, subcircular to roundly triangular in equatorial contour; triradiate ridges extending for three fourths or more of spore radius; curvaturae not decipherable. Exosporium comparatively thin, distinctly reticulate, with wide rectangular or polygonal lumina. Mesosporium imperceptible, probably filling whole of spore cavity.



TEXT-FIG. 6 — *Horstisporites biswasii* sp. nov.— Megaspore in dry condition showing well-developed reticulate pattern of the exine, × 200.

Dimensions — Equatorial diameter — dry: 320-450 μm, wet: 420-600 μm; triradiate lamellae: 10-15 μm broad and equally high; exosporium 10-15 μm thick, meshes 20-60 μm, muri 10-15 μm.

Comparison — *Horstisporites microlumenous* Dettmann, 1961 has a comparable size range but differs in having meshes of smaller diameter. *H. foveatus* Marcinkiewicz, 1962, too, has a finer reticulation pattern on the exosporium. *H. imperfectus* Reinhardt, 1969 has a similar shape and size range but can be distinguished by the free-ending muri of the reticulum and so can also *H. harrisii* (Murray) Potonié.

Holotype — Pl. 7, fig. 2; slide no. BSIP 8194; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau, Kachchh District.

Derivation of name — After Dr S. K. Biswas, Oil and Natural Gas Commission for his valuable contributions to Mesozoic lithostratigraphy of the Kachchh Basin.

Turma — *Zonales* (Bennie & Kidston, 1886 ex Ibrahim) emend. Potonié, 1956

Subturma — *Auritotriletes* Potonié & Kremp, 1954

Infraturma — *Auriculati* Schopf ex Potonié & Kremp, 1954

Genus — *Valvisisporites* Ibrahim, 1933 emend. Potonié & Kremp, 1954

Type species — Valvisisporites trilobus Ibrahim, 1932 in Potonié, Ibrahim & Loose.

Diagnosis (translated from Potonié and Kremp, 1954, p. 154) — Trilete megaspores, equatorial outline rounded-triangular to trilobate as a consequence of not always prominent broadening of the exine (auriculae) at the ends of trilete rays; a cingulum more or less poorly developed; trilete rays usually extending up to equator; exosporium more or less laevigate; curvaturae if distinguishable, near equator and parallel to it.

Remarks — Ibrahim (1933) defined the genus as of trilete spores with lobate extension of the exospore. Potonié and Kremp (1954) diagnosed the genus in detail. Zoldani (1966) worked out the taxonomy and stratigraphical distribution of the genus in the Carboniferous of Lublin District. Lachkar (1968, p. 8) redefined the genus but apparently his circumscription is not different from that given by Potonié and Kremp.

Valvisisporites minor Singh, Srivastava & Roy, 1964

Pl. 10, fig. 1

Diagnosis (after Singh, Srivastava & Roy, 1964, p. 290) — Megaspores subtriangular in equatorial outline, cingulate, trilete. Cingulum weakly developed around *extrema lineamenta* except for at apices against ray ends where forms auriculae. Trilete rays extending up to auriculae margin. Arcuate ridges not distinct. Mesosporium seen sometimes.

Dimensions — Equatorial diameter — wet: 220-265 μm; Auriculae: 28-33×43-57 μm; trilete rays: 19-28 μm high; exosporium: 5-8 μm thick.

Remarks — This species does not occur in our collection. It seems possible that the two specimens illustrated by Singh, Srivastava and Roy (1964, pl. 4, figs 49, 50) represent badly preserved or over macerated specimens of *Minerisporites auriculatus* Singh, Srivastava & Roy, 1964.

Holotype — BSIP slide no. 1692; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau.

Genus — *Umiaspora* Singh, Srivastava & Roy, 1964

Type Species — Umiaspora bosei Singh, Srivastava & Roy, 1964.

Diagnosis (after Singh, Srivastava & Roy, 1964, p. 293) — Megaspores, triangular in equatorial outline, trilete, zonate. Exosporium more or less laevigate.

Umiaspora bosei Singh, Srivastava & Roy, 1964

Pl. 8, fig. 10

Diagnosis (after Singh, Srivastava & Roy, 1964, p. 293) — Megaspores more or less triangular in equatorial outline; equatorial zona membraneous, almost uniformly broad all around, margin smooth; trilete rays straight, extending up to margin of zona, tecta raised; exosporium more or less smooth.

Dimensions — Equatorial diameter — wet: 215-255 μm; zona: 28-30 μm wide; trilete ray tecta: 2.5 μm thick; exosporium 2.5 μm thick.

Remarks — This species is not represented in our collection. Of the two specimens illustrated by Singh, Srivastava and Roy (1964, pl. 5, figs 61, 62), only the holotype is traceable.

Holotype — BSIP slide no. 1750; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau.

Occurrence — Trambau-Pur.

Genus — *Erlansonisporites* Potonié, 1956

Type Species — Erlansonisporites (Selaginellites) erlansonii (Miner, 1932) Potonié, 1956.

Diagnosis (abstracted from Potonié, 1956, p. 47) — Genotype 889 μm, without projecting muri (as seen from the photograph), equator circular, trilete not at all or only slightly recognizable due to strong reticulation. Muri of reticulum grade into thin lamellae, uniformly developed all over exine, visibly noticeable at spore equator,

Erlansonisporites indicus sp. nov.

Pl. 7, figs 3-6; Pl. 8, fig. 1

1964 *Erlansonisporites* cf. *erlansonii* (Miner) Pot., 1956: Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 289, pl. 4, fig. 41.

Diagnosis — Megaspores trilete, circular to subcircular equatorial contour. Triradiate ridges usually inconspicuous in dry specimens under incident light; however, distinct in differentially macerated specimens, three-fourths to four-fifths of spore radius long, commissures distinct, lips thickened. Exosporium ornamented with irregular, convoluted appendages, separate or occasionally anastomosing, forming an incomplete reticulum simulating a pseudozona. Mesosporium indistinct.

Dimensions — Equatorial diameter — dry: 400-600 μm, wet: 450-900 μm; exosporium: 15-30 μm thick, appendages: 20-100 μm high.

Comparison — *Erlansonisporites erlansonii* approaches closely the new species but differs in not having identifiable triradiate rays even in translucent specimens (Miner, 1932, figs 1-3). *E. sparassis* (Murray, 1939) Potonié, 1956 has shorter appendages. *E. spinosus* Bergad, 1978 is reported to have echinae in the interspaces between appendages.

Holotype — Pl. 7, fig. 6; slide no. BSIP 8197; Lower Cretaceous, Bhuj Formation, Lower Member, Trambau, Kachchh District.

Occurrence — Trambau-Pur; Madhapur well; Kera well; Sukhpur well; Gadshisa-Kharod; Ugedi well; Dhamae-Chawad.

Subturma — *Zonotriletes* Waltz, 1935

Infraturma — *Zonati* Potonié & Kremp, 1954

Genus — *Minerisporites* Potonié, 1956

1964 *Auriculozonospora* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 294.

Remarks — Singh, Srivastava and Roy (1964) differentiate *Auriculozonospora* from *Minerisporites* through the presence of conspicuous wings in the winged lamellae of the trilete rays. However, we have not been able to observe this character in the type specimen of the genus.

Type species — *Minerisporites* (*Selaginellites*) *mirabilis* (Miner, 1935) Potonié, 1956.

Diagnosis (*extracted from Potonié, 1956, p. 67*) — Megaspores trilete, zonate, central body equator subtriangular to nearly circular. Y-rays continue onto zona, tecta partly strongly elevated, lobe, plate or board-shaped. Meridional contour of spore body semicircular to circular. Exosporium reticulate.

Remarks — The genus *Minerisporites* shows a close resemblance with the Palaeozoic megaspore *Triangulatisporites*. The latter, however, is distinguished, amongst other features, by not having elevated tecta. Potonié (1956) separated *Minerisporites* megaspores from those recovered from the fructification *Selaginellites* as in his opinion only those dispersed megaspores should be referred to the genus *Selaginellites* which exactly correspond to the *in situ* megaspores. He desired that *Selaginellites* should not be considered as a dumping box in which diverse taxa are placed so that one gradually forgets about them.

Minerisporites mineri (Dev, 1961) comb. nov.

Pl. 8, figs 2, 5, 7, 9

1961 *Erlansonisporites mineri* Dev, *Palaeobotanist*, **8** (1, 2), p. 45, pl. 2, fig. 14.

Diagnosis — Megaspores circular to subtriangular in shape, zonate, trilete. Zona equatorial, more or less equally wide all round. Trilete laesurae sharp, extending beyond spore body and onto zona, tecta raised, skinny. Exosporium reticulate, lumina polygonal, muri raised, narrow. Mesosporium indisntict.

Dimensions — Equatorial diameter — dry: 250-500 μm, wet: 252-500 μm; triradiate lamellae: 6-30 μm high, 116-200 μm long; exospore meshes: 15-30 μm, muri: 3-10 μm.

Holotype — Dev, 1961, pl. 2, fig. 14, slide no. BSIP 28723-3; Lower Cretaceous, Jabalpur Formation, Sher River Section near Sehora, Narsinghpur District.

Occurrence — Trambau-Pur; Devisar-Bukhi; Ugedi well; Dharesi-Korawadi.

Remarks — A re-examination of the holotype of *Erlansonisporites mineri* Dev showed the presence of a zona and hence the species has been re-assigned to the genus *Minerisporites*. *M. mineri* shows an apparent

resemblance with *M. auriculatus* Singh, Srivastava & Roy, 1964 but can easily be distinguished by its broader meshes of the exospore reticulum and in the absence of an auricle.

Minerisporites dharesiensis sp. nov.

Pl. 10, fig. 2

Diagnosis — Megaspore subcircular, zonate trilete. Zona associated with thick folds. Trilete laesurae distinct, extend up to equator and onto zona. Exosporium fine-reticulate, after progressive maceration becoming psilate to fine-granulate. Mesosporium distinct, subtriangular, 5-6 pairs of nipple-like protuberances arranged along each trilete ray.

Dimensions—(Solitary specimen)—Equatorial diameter-dry 350×460 μm, wet: 450×480 μm; Zona: 35-45 μm; Laesurae: 30-40 μm thick.

Holotype — Pl. 10, fig. 2, slide no. BSIP 8207; Lower Cretaceous, Bhuj Formation, Lower Member, Korawadi River Section near Dharesi, Kachchh District.

Comparison — The most characteristic features of *Minerisporites dharesiensis* is the presence of a mesosporium with nipple-like protuberances in the inter-ray areas, a character which it shares with *M. auriculatus* (= *M. mesosporeoides*) Singh, Srivastava & Roy, 1964 reported from Pur River Section near Trambau. The latter species, however, has an smaller overall size and fewer (3-5) protuberances in the inter-ray area of a subcircular mesosporium.

Occurrence — Dharesi-Korawadi.

Minerisporites cutchensis Singh, Srivastava & Roy, 1964

Pl. 9, figs 1, 2

1964 *Minerisporites cutchensis* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 293, pl. 5, figs 63, 64.

Diagnosis (*abstracted from Singh, Srivastava & Roy, 1964*, p. *293*) — Trilete megaspore, more or less roundly triangular in equatorial outline, laterally more or less globose. Equatorial flange membraneous, widest opposite ray ends. Trilete laesurae thin, often undulating, much raised, extend up to zona margin. Exosporium reticulate, mesh lumina polygonal to isodiametric. Mesosporium more or less triangular, comparatively small, with 2-4 cushions in each inter-ray area.

Dimensions — Equatorial diameter — wet: 295-402 μm; Zona: 25-44 μm; Ray height: 22-36 μm; Exosporium: 4.5-7 μm thick, muri: 2-6 μm high, lumina: 8-15 μm in diameter.

Holotype — BSIP slide no. 1744; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau, Kachchh District.

Occurrence — Trambau-Pur; Nangor-Pat; Kera well; Dharesi-Korawadi.

Minerisporites auriculatus Singh, Srivastava & Roy 1964

Pl. 8, figs 3, 4, 8, 11, 12; Pl. 9, figs 3, 5

1964 *Minerisporites auriculatus* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 293, pl. 5, fig. 65.

1964 *Minerisporites mesosporeoides* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 293, pl. 5, figs 66-68.

Diagnosis (*from Singh, Srivastava & Roy 1964, p. 293*) — Megaspores trilete, zonate, overall subtriangular. Zona membraneous, forming auriculae at ray ends, Trilete laesurae extending on to zona. Exosporium reticulate, lumina isodiametric. Mesosporium clear in over macerated specimens, subcircular, often variously infolded.

Dimensions — Equatorial diameter — wet: 248-316 μm; zona: 20-40 μm wide, 44-53 μm at ray ends (auriculae); trilete laesurae: 20-43 μm high; exospore mesh muri: 1-3 μm wide, lumina: 4-7 μm in diameter.

Remarks — *Minerisporites auriculatus* very closely resembles *M. cutchensis*. The major difference between the two species is in the extant of zona. In *M. cutchensis*, the zona is usually narrow in inter-ray areas and flares up against the ray-ends. In fact, the zona is not exactly equatorial in position but is displaced towards proximal side and sits on the arcuate ridges. In *M. auriculatus*, on the other hand, the zona is comparatively wide all round, but forming a sort of auriculae against the ray ends. The mesosporia in the two species

are also distinct, as is also the reticulation of the exosporium. As a mesosporium has been observed in *M. auriculatus*, there is no justification now for maintaining *M. mesosporeoides* as a separate species.

Lectotype — BSIP slide no. 1753; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau. A re-examination of type slides of both *auriculatus* and its junior synonym *M. mesosporeoides* (BSIP slide no. 1753 and 1668 respectively) shows that none of the specimens of these species figured by Singh, Srivastava and Roy (1964, pl. 5, figs 65-68) are locatable. As such under Article 7.5 of the International Code of Botanical Nomenclature, BSIP slide no. 1753 is designated as the lectotype.

Occurrence — Trambau-Pur; Devisar-Bukhi; Ugedi well.

Minerisporites reticulatus (Singh, Srivastava & Roy) comb. nov.

Pl. 11, figs 3-6

1964 *Auriculozonospora reticulata* Singh, Srivastava & Roy *Palaeobotanist*, **12** (3), p. 294, pl. 5, fig. 70 *non* figs 69, 71.

Diagnosis — Megaspore zonate, trilete, overall shape subtriangular, spore body subcircular. Zona equatorial, thin, narrow, flaring up against ray ends forming auriculae. Trilete rays reaching up to equator, labra raised, membraneous. Exosporium reticulate, meshes comparatively large.

Dimensions — Overall size — wet: 175-225 μm; zona: 10-20 μm wide, auriculae: 30-40 μm wide; trilete lamellae: 25-40 μm high; exosporium: 3-5 μm thick, lumina: 8-16 μm in diameter.

Holotype — BSIP slide no. 1709; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau.

Comparison & Remarks — Singh, Srivastava and Roy (1964) erected this taxon as the type species of a new genus, viz., *Auriculozonospora*. However, we do not find sufficient characters to differentiate this genus from *Minerisporites*. *M. reticulatus* comb. nov. differs from other species of the genus in its smaller overall size and comparatively large-meshed reticulum of the exosporium.

Occurrence — Trambau-Pur.

Genus — ***Paxillitriletes*** **Hall & Nicolson, 1973**

1954 *Thomsonia* Mädler, *Geol. Jahrb.*, **70**, p. 150, *non Thomsonia* Wallich, 1830.

1956 *Thomsonia* Mädler, 1954: Potonié, *Beih. geol. Jahrb.*, **23**, p. 71.

Remarks — The generic name *Thomsonia* being pre-occupied for an extant Araceae (Wallich, 1830), the generic name *Thomsonia* Mädler, 1954, erected for fossil megaspores, was changed to *Paxillitriletes* by Hall and Nicolson (1973, p. 319).

Type species — *Paxillitriletes* (*Thomsonia*) *reticulatus* (Mädler, 1954) Hall & Nicolson, 1973.

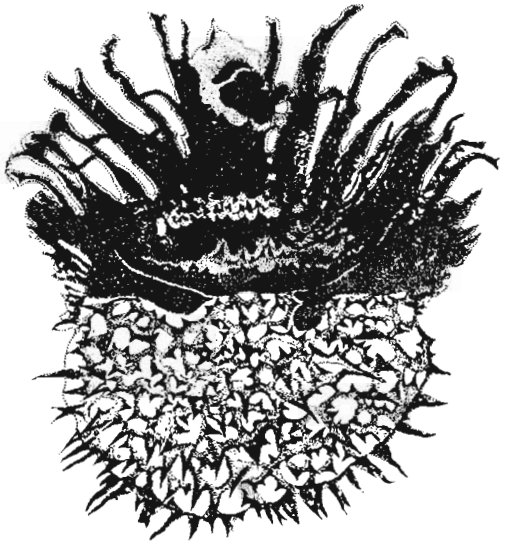
Diagnosis (*abstracted from Potonié, 1956, p. 71*) — Type species 300-420 μm. Trilete megaspores, equatorial contour more or less circular or triangular with concave sides. Meridian (without hairs) more or less circular. Y-tecta and adjacent region bearing long capilli or lobed appendices. Contact areas reach or do not reach equator, bordered by more or less distinct curvaturae which form a cingulum (equatorial margin of Mädler). Tecta sometimes projecting beyond curvaturae and forming small to large auriculae. Exosporium reticulate, verrucate or conate.

Paxillitriletes battenii sp. nov.

Pl. 9, fig. 6; Pl. 10, figs 3-5; Text-fig. 7

1969 cf. B. *Thomsonia pseudotenella* (Dijkstra, 1951) Mädler, 1954: Batten, *Palaeontology*, **12** (2), pp. 341, 342, pl. 65, figs 1-8; pl. 67, fig. 16; Valanginian, Ashdown Sand, Britain.

Diagnosis — Megaspores, trilete, equatorial and polar contours both circular, mostly preserved in lateral view and hence trilete laesurae not clearly decipherable. Trilete lamellae extending up to spore equator where connected by arcuate ridges, latter more extensively developed at lamellae ends forming highly irregular auriculae; each laesura associated with a number of branched or unbranched filamentous or flattened appendages which may be joined at their bases or along whole length. Exosporium spinate, both proximally and distally. Spines characteristically pitted, sometimes very long and bearing vesicles both at base and apex. Spines sometimes partly connected at base by low ridges form-



TEXT-FIG. 7 — *Paxillitrilètes battenii* sp. nov.— Megaspore in dry condition showing well-developed unbranched and branched appendages associated with trilete laesurae and exosporium with more or less straight filamentous processes on both the surfaces, × 100.

ing an incomplete 'reticulum'. Mesosporium not seen.

Dimensions — Equatorial diameter — dry: 500-800 μm, wet: 550-900 μm; auriculae: up to 85 μm long, 60 μm wide; laesurae appendages: 100-350 μm long, 10-120 μm wide at widest; exosporium: 8-10 μm thick, spinate processes 10-110 μm long.

Comparison — The megaspores resemble in most of the characters cf. B. *Thomsonia pseudotenella* figured by Batten (1969) from the Wealden of England, except for in size which is 190-370 μm for the latter. These megaspores differ from *Thomsonia pseudotenella* Dijkstra, 1951 in having spinate ornament (10-110 μm long) as compared to conate ornament in the latter (mostly 5 μm, very rarely 70 μm). *Paxillitriletes midas* (Dijkstra, 1951) Hall & Nicolson, 1973 and *P. divisus* (Dijkstra, 1951) Hall & Nicolson, 1973, both have well-developed auriculae. *P. phyllicus* (Murray, 1939) Hall & Nicolson, 1973 differs in having very high (70-140 μm), convoluted triradiate lamella which are in the form of 'Plates'. *P. dakotaensis* (Hall, 1963) Hall & Nicolson, 1973 differs in having robust and comparatively few hook-like or spike-like projections on the distal surface. Some of the spines in *P. battenii* are also hook-like but they are comparatively slender.

Holotype — Pl. 10, fig. 3, slide no. BSIP 8208; Lower Cretaceous, Bhuj Formation, Lower Member, Pat River Section near Nangor, Kachchh District.

Derivation of name — After Dr D. J. Batten, who reported apparently similar megaspores from the British Wealden.

Occurrence — Nangor-Pat; Madhapur well.

Paxillitriletes cutchensis (Singh, Srivastava & Roy, 1964) comb. nov.

Pl. 2, fig. 9; Pl. 11, fig. 7

1964 *Thomsonia cutchensis* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 295, pl. 5, figs 73, 74.

Diagnosis (*restated from Singh, Srivastava & Roy, 1964, p. 295*) — Megaspores, equatorial contour more or less rounded, lateral outline also circular. Triradiate lamellae very high, fluted, more prominent at apices extending into apical auriculae. Exosporium reticulate all over, intersections of muri with spinate-conate processes.

Dimensions — Equatorial diameter — wet: 450-460 μm (inclusive of zona); zona: 30-60 μm wide in interradial regions, 70-110 μm at apices; triradiate lamella 148-162 μm high; exosporium: 12-15 μm thick, reticulum lumina: 10-18 μm, muri intersection projections: 15-28 μm high, apical spinae: 45-90 μm long, 8-10 μm broad.

Holotype — BSIP slide no. 1683; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau, Kachchh District.

Occurrence — Trambau-Pur; Nangor-Pat; Dhamae-Chawad.

Genus — *Dijkstraisporites* Potonié, 1956

Type species — *Dijkstraisporites* (*Triletes*) *helios* (Dijkstra, 1951) Potonié, 1956.

Diagnosis (*translated from Potonié, 1956, p. 74*) — Megaspores trilete, zonate to coronate, body equator circular to subtriangular, overall equator with zona more or less circular. Trilete rays continue into zona, tecta having corona-like appendages or more or less free capilli. Zona membraneous, more or less coherent or forming

a corona at margins, may be broader against ray-ends. Exosporium reticulate to granulate-verrucate.

Dijkstraisporites filiformis Singh, Srivastava & Roy, 1964

Pl. 11, figs 1-2

1964 *Dijkstraisporites filiformis* Singh, Srivastava & Roy, *Palaeobotanist*, **12** (3), p. 295, pl. 6, figs 75, 76.

Diagnosis (after Singh, Srivastava & Roy, 1964, p. 295) — Megaspores roundly triangular in equatorial outline, zonate, trilete. Zona equatorial, more or less translucent, leathery, granulate, apparently formed by fusing of branched and ramifying radial rays (or ridges). Trilete laesurae often robust, extending onto the zona. Exosporium thick, reticulate, lumina polygonal, muri faint and low, at intersections having very long unbranched slender filiform capilli.

Dimensions — Equatorial diameter — wet: 1086-1344 μm; equatorial zona: 283-384 μm wide; trilete rays: 10-25 μm broad, 8-12 μm high; exosporium: 8-28 μm thick, lumina 17-28 μm in diameter, capilli: 175-240 μm long, 8-16 μm broad at base.

Holotype — BSIP slide no. 1747; Lower Cretaceous, Bhuj Formation, Lower Member, Pur River Section near Trambau.

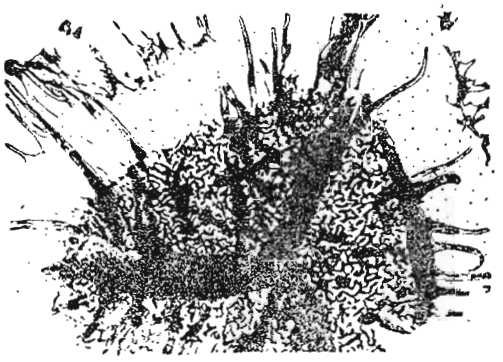
Occurrence — Trambau-Pur; Sukhpur well; Ugedi well.

Dijkstraisporites grantii sp. nov.

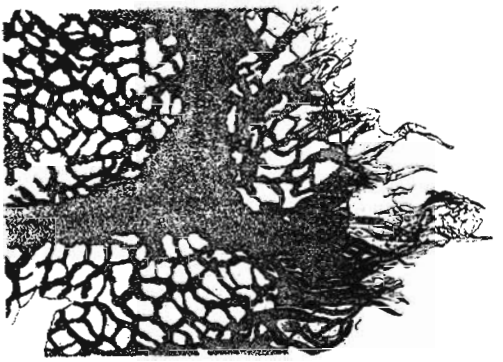
Pl. 12, figs 3-5; Text-fig. 8

Diagnosis — Megaspore subtriangular, central body subtriangular, triradiate mark well-developed, thick slightly raised, extending beyond central body and entering part of zona, rod-like processes sparsely distributed on central body, exosporium of central body rugulate; zona wide, translucent, usually studded with fine verrucate structures, rarely bearing rod-like processes at places.

Dimensions — Equatorial diameter — wet: 850 μm, maximum equatorial width of zona: 230 μm; width of triradiate ridge: 40 μm; maximum length of rod-like processes: 240 μm.



TEXT-FIG. 8 — *Dijkstraisporites grantii* sp. nov.— Megaspore (in part) in wet condition showing triangular, rugulate central-body sparsely bearing rod-like processes and well-developed triradiate-ridge, × 150.

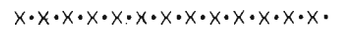
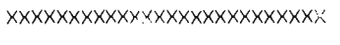
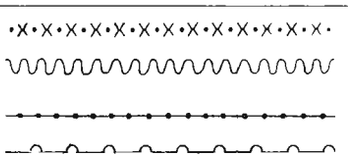
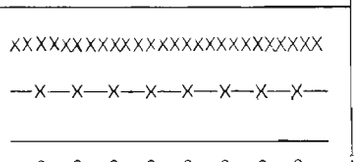
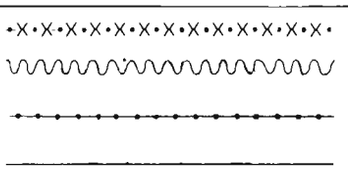
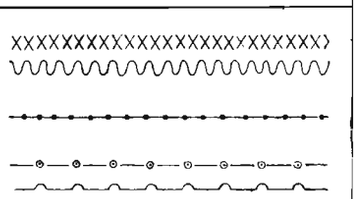
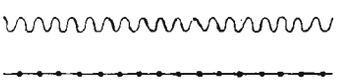
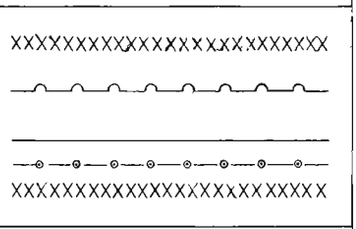
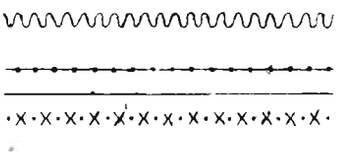
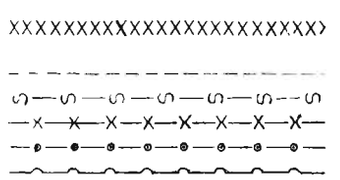
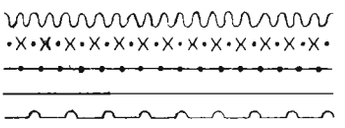
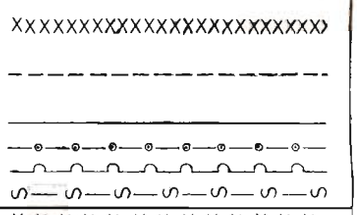
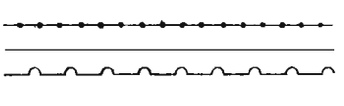
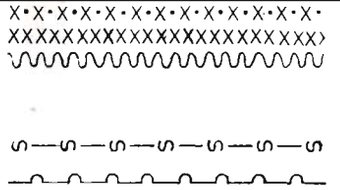
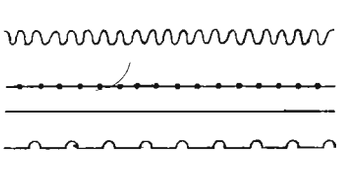
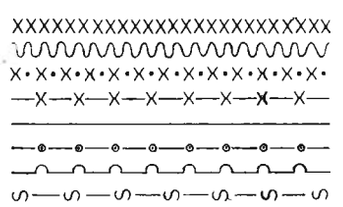
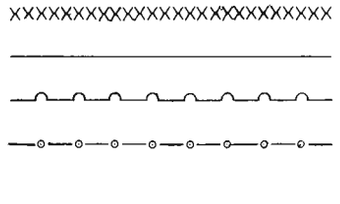


TEXT-FIG. 9 — *Dijkstraisporites triangulatus* Singh, 1964 — Megaspore (in part) in wet condition showing well-pronounced reticulum of central body and also presence of filiform processes at its peripheral region, well-pronounced triradiate-ridge and ill-developed zona, × 150.

Comparison — *Dijkstraisporites grantii* sp. nov. resembles *D. filiformis* Singh, Srivastava & Roy in shape and in the presence of filiform appendages on the central body, but the latter differs from the former by its large size (1086-1344 μm), delicate nature of filiform appendages and in the absence of rugulate ornamentation on the central body.

Occurrence — Sukhpur well.

Holotype — Pl. 12, figs 3-5, slide no. BSIP 8211; Lower Cretaceous, Bhuj Formation, Lower Member, Shallow well 10 kilometer from Bhuj on Bhuj-Lakhpat Road.

SIGNIFICANT GENERA	JURASSIC	CRETACEOUS
BANKSISPORITES		
HUGHESISPORITES		
BACUTRILETES		
VERRUTRILETES		
HORSTISPORITES		
PAXILLITRILETES		
ERLANSONISPORITES		
MINERISPORITES		
DIJKSTRAISPORITES		

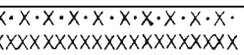
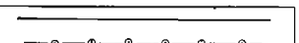
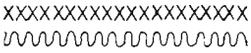
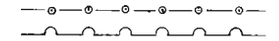
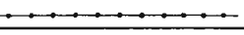
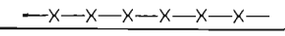
AUSTRALIA & TASMANIA		ENGLAND	
INDIA & PAKISTAN		NETHERLAND	
GREENLAND		CANADA	
GERMANY		U.S.A.	
POLAND		S. AMERICA	

CHART 1

	Trambau	Pat River	Madhapur	Kera	Sukhpur	Gadhsisa	Ugedi	Bukhi River	Chawad River	Walkamota	Guneri	Dharesi
Banksisporites kachchhensis				+	+	+	+			+		+
Hughesisporites rajnathii					+		+					
H. singhii			+		+							
Hughesisporites sp.	+										+	
Verrutriletes royii					+							+
V. stolickzae					+							
V. triangulatus	+											+
V. sp.												+
Bacutriletes cutchensis												
B. dijkstrae										+	+	+
B. srivastavae	+										+	+
Horstisporites areolatus				+			+		+	+		+
H. sp. cf. *H. semireticulatus*	+											
H. biswasii	+											
Valvisisporites minor	+											
Umiaspora bosei	+											
Erlansonisporites indicus	+		+									
Minerisporites auriculatus	+	+		+	+	+	+	+	+			
M. cutchensis	+			+			+					
M. dharesiensis												+
M. mineri	+						+					+
M. reticulatus	+							+				+
Paxillitriletes battenii			+									
P. cutchensis	+	+							+			
Dijkstraisporites filiformis	+											
D. grantii					+		+					
D. triangulatus					+		+					

CHART 2

Derivation of name — After Col. Grant, who provided the first geological map of Kachchh region.

Dijkstraisporites triangulatus Singh, 1964

Pl. 12, figs 1, 2; Text-fig. 9

Diagnosis (modified after Singh, 1964, p. 161) — Trilete, zonate megaspore; equatorial outline of the central body triangular with convex sides, surrounding equatorial zona giving an almost circular outline; zona transluscent, membraneous, thinning out towards margin, not very wide as compared to diameter of central body; large number of 10 μm thick rays projecting into zona from central body, running over 2/3 of their length, separately embedded in zona, triradiate lamellae thick, high and flap-like, extending to zona margin; both proximal and distal surfaces of central body coarsely reticulate, enclosing lumina of variable size.

Dimensions — Equatorial diameter: 737 μm, width of zona: 141 μm; width of triradiate lamellae: 50 μm, height of lamellae 192 μm; width of lumina: 20-45 μm, width of muri: 4 μm.

Holotype — Singh, 1964, pl. 26, fig. 1, slide no. Mega 56.

Description of Kachchh Specimens — Trilete zonate megaspores, subtriangular. Central body subtriangular, triradiate ridge distinct, widest near contact area, and gradually tapering towards equatorial region, devoid of filiform appendages; exine reticulate both proximally and distally, muri at central region devoid of any filiform processes, those near peripheral region bearing filiform processes. Zona narrow, transluscent, supported intermittently by thread-like processes arising from central body.

Dimensions — Equatorial diameter: 810 μm, maximum width of zona: 130 μm; width of triradiate lamellae: 64 μm near contact area and 30 μm near periphery; width of lumina: 18-34 μm.

Occurrence — Ugedi well.

Remarks — The present species can apparently be mistaken for *Dijkstraisporites filiformis* Singh, Srivastava & Roy, 1964, but the former can easily be distinguished by its overall small size, ill-developed zona, scarcity of filiform processes on the central body and deep-seated reticulate exosporium.

MEGASPORE TYPE A

Pl. 13, figs. 3, 7, 8

Description — Megaspore more or less circular, triradiate mark not discernible; exosporium thick, studded with broad-based spines; spines probably restricted at the equatorial margin and certain points in peripheral region; central portion of spore body coarsely rugulate, muri of the rugulae are so high that in dry condition these probably gave the appearance of spines; mesosporium not seen.

Dimensions — Equatorial diameter — dry: 490 μm, wet: 525 μm; thickness of exosporium: 65 μm, length of spinate ornament: 30-55 μm

Occurrence — Sukhpur well.

MEGASPORE TYPE B

Pl. 13, fig. 9

Description — Megaspore more or less circular, triradiate mark not distinguishable; exosporium thin, folded at places, reticulate, reticulum very fine; mesosporium small.

Dimensions — Equatorial diameter — wet: 338 μm; diameter of mesosporium: 173 μm.

Occurrence — Devisar-Bukhi.

DISCUSSION

Megaspores from the Mesozoic sedimentaries of the Kachchh Basin were first reported by Singh, Srivastava and Roy (1964). These authors described and illustrated 19 types of megaspores referable to 12 genera. Most of the specimens were recovered from the Pur River Section near Trambau; a few came from the open pit near Guneri. During the course of present investigation megaspores have been recovered from Pur River Section near Trambau, Pat River Section near Nangor, Korawadi River Section near Dharesi, Chawad River Section near Charkhada-Dhamae Road-crossing, Kharod River Section near Gadhsisa and from 5 shallow wells, one each near Madhapur, Kera,

Sukhpur, Ugardi (Ugedi) and Walka Mota. The new record and a revision of earlier work now reveal a megaspore assemblage comprising 27 species referable to 11 genera. A distribution of various species at different localities is summarised in Chart 1.

The distributional pattern of different species shows that all these constitute one assemblage zone. Almost all the genera are represented by one or the other species from Trambau in the east to Dharesi in the west. Of course, the number of taxa represented at some localities, e.g. Trambau, Sukhpur, Ugedi and Dharesi, is relatively more than at other localities, e.g. Madhapur, Kera, Gadhsisa, Walka Mota, Guneri, etc. This variation in representation of taxa may be due to local environmental conditions, or due to bias in collection of samples. According to Sweet (1979) well-preserved diverse populations may represent transported assemblages of non-marine or nearshore deposition.

The present megaspore assemblage hardly has any element which could help in fixing a definite age to the sediments. Almost all the genera are wide ranging and occur in Lower Jurassic to Lower Cretaceous sediments (Chart 2).

From the Indian subcontinent, only two Mesozoic megaspore assemblages have been recorded. The Liassic assemblage from the variegated shales of Nammal Gorge, Pakistan (Sah & Jain, 1968) has *Banksisporites*, *Hughesisporites*, *Minerisporites* and *Nathorstisporites*. Except for the genus *Nathorstisporites* all genera are represented in Kachchh. The megaspore assemblage from Sehora-on-Sher, Madhya Pradesh has *Minerisporites*, *Saccarisporites* and *Dijkstraisporites*, all of which are represented in Kachchh, too. The age of the Sehora sediments has, in recent years, become controversial and is variously regarded as Upper Jurassic (Bharadwaj, Kumar & Singh, 1972) to Lower Cretaceous (Singh, 1970; also see Maheshwari & Jana, 1983).

The genus *Paxillitrilétes*, a very characteristic form of Lower Cretaceous of The Netherlands and England (Dijkstra, 1949, 1951, 1959; Batten, 1969) and of Canada (Singh, 1964, 1971; Gunther & Hills, 1972) is, however, also known from the Jurassic of England (Murray, 1939; Harris, 1961), Poland (Marcinkiewicz, 1960), Arctic Canada (Sweet, 1979) and Australia (Filatoff, 1975).

The present megaspore assemblage is definitely of pre-Aptian age due to the absence of the genera *Pyrobolospora*, *Balmeisporites*, *Ariadnaesporites*, etc. The high incidence of species of the genus *Minerisporites* alongwith the occurrence of *Paxillitriletes battenii* and *Dijkstraisporites* spp. does, however, indicate a Lower Cretaceous age (cf. Hughes, 1958; Tschudy, 1976).

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EXPLANATION OF PLATES

(All the figured slides have been deposited with the repository of Birbal Sahni Institute of Palaeobotany)

PLATE 1

1-7. *Banksisporites kachchhensis* sp. nov. 1. Holotype in dry condition showing subcircular shape and contact area well defined by mediumly developed arcuate ridges. × 50; 2. Holotype after maceration showing a faint mesosporium. × 50, slide no. 8174; 3. Dry specimen showing scabrate-coarsely granulate exosporium. × 50; 4. The same after maceration. × 50, slide no. 8175; 5 & 6. Another spore in dry and macerated conditions. × 50, slide no. 8176; 7. A subcircular spore in dry condition showing well-developed triradiate mark, arcuate ridges and granulate exosporium. × 50, preserved in macerated condition, slide no. 8177.

PLATE 2

1, 2, 8. *Hughesisporites singhii* sp. nov. 1. Spore in dry condition showing well-developed triradiate-mark and ridges near contact area. × 100, preserved in macerated condition, slide no. 8178; 2. Holotype in macerated condition. × 50, slide no. 8179; 8. Holotype under incident light. × 100.

3-6. *Verrutriletes* type. 3. A spore in equatorial view showing verrucae-like structures on equatorial region. × 50; 4. Proximal view of the same. × 50, slide no. 8180; 5. Spore with verrucae-like structures mostly confined to the equatorial margin and relatively less on the proximal side. × 50 (spore consumed during maceration), negative no. 6335; 6. Scanning electron micrograph of a part of a spore to show nature and attachment of the verrucae-like structures on the exosporium. × 300, negative no. 2803.

7. *Hughesisporites rajnathii* sp. nov. Proximal view of the holotype in dry condition showing well-developed sinuous triradiate-mark and well-pronounced ridges in contact area. × 100, preserved in macerated condition, slide no. 8181.

9. *Paxillitriletes cutchensis* Singh, Srivastava & Roy, 1964, slide no. 1702.

PLATE 3

1. *Hughesisporites rajnathii* sp. nov. A macerated spore showing well-developed ridges seen in dry condition transformed into interwoven finger-like processes. × 100, slide no. 8182.

2. *Triletes carbunculus* Dijkstra type of megaspore in dry condition showing well-developed triradiate-mark and crowded verrucae-like structures on the equatorial area. × 50 (spore consumed during maceration), negative no. 6358.

3, 4. *Verrutriletes triangulatus* sp. nov. 3. Spore in dry condition showing well-developed, slightly sinuous triradiate-mark and crowded verrucae. × 100; 4. Same spore after maceration showing the ultimate dissolution of verrucae leaving an almost smooth exosporium. × 100, slide no. 8183.

5-8. *Verrutriletes royii* sp. nov. 5. Spore in dry condition. × 100, preserved in macerated condition, slide no. 8184; 6. Holotype in dry condition. × 100; 7. Holotype at intermediate stage of maceration showing verrucae at the central region only. × 100; 8. Holotype further macerated showing more or less complete dissolution of verrucae. × 100, slide no. 8185.

PLATE 4

1, 2. *Bacutriletes cutchensis* Singh, Srivastava & Roy, 1964. 1. A megaspore under incident light showing a small triradiate-mark and evenly distributed baculae. × 100; 2. Part of the above spore enlarged after maceration. × 200, slide no. 8186.

3-6. *Bacutriletes srivastavae* sp. nov. 3. Holotype in dry condition showing triradiate-mark and well-developed bacula. × 100; 4. The above spore after maceration showing evenly distributed bacula all over the spore-body. × 100; 5. A part of megaspore in figure 4 magnified to show the nature of the bacula. × 150, slide no. 8187; 6. Scanning electron micrograph of same type of spore. × 100, negative no. 2796.

PLATE 5

1. *Verrutriletes triangulatus* sp. nov. Holotype in macerated condition with triangular mesosporium. Note that the verrucae on the exosporium have almost completely disappeared. × 100, slide no. 8188.

2-5. *Bacutriletes dijkstrae* Singh, Srivastava & Roy 1964. 2-3. Distal and proximal views of a megaspore in dry condition. × 50; 4. The above megaspore after maceration showing finger-like bacula more concentrated towards equatorial region. × 50, slide no. 8189; 5. A part of the lectotype enlarged to show the nature of bacula. × 100, slide no. 1722.

6. *Verrutriletes royii* sp. nov. Macerated stage of the megaspore illustrated in Pl. 3, fig. 5 × 100, slide no. 8184.

7. *Verrutriletes* type megaspore after maceration. × 100, slide no. 8191.

PLATE 6

1, 2. *Horstisporites areolatus* (Harris) Potonié, 1956. 1. Megaspore in dry condition. × 100; 2. The same spore after maceration and mounted in Canada balsam. × 75, slide no. 8192.

3, 4. *Horstisporites* sp. Scanning electron micrograph of a spore showing net-like appearance of the exosporium and fairly high muri of the reticulum. × 100, negative no. 2797; 4. Part of the exosporium enlarged to show the nature of elements present within the lumina of the reticulum which is usually invisible in optical microscope. × 300, negative no. 2798.

5. *Horstisporites* sp. *H. semireticulatus* Jung. Megaspore in dry condition. × 50, preserved in macerated state, slide no. 8193.
6, 7. *Horstisporites biswasii* sp. nov. 6. Spore in proximal view. × 100; 7. The same megaspore after maceration. × 100 (spore consumed during maceration), negative nos. 6953 and 6993.

PLATE 7

1. *Horstisporites areolatus* (Harris) Potonié, 1956. A megaspore in dry condition showing well-developed reticulate exosporium. × 50 (spore consumed during maceration), negative no. 6339.
2. *Horstisporites biswasii* sp. nov. Holotype after maceration. × 100, slide no. 8194.
3-6. *Erlansonisporites indicus* sp. nov. 3-4. Megaspores in dry condition showing raised muri which give the appearance of diaphanous appendages. No triradiate-mark demarcable in dry condition. × 100 (megaspore of figure 4 consumed in maceration; negative no. 7091), slide no. 8195; 5. Another macerated megaspore. × 50, slide no. 8196; 6. Holotype after maceration showing irregularly outlined zona and the triradiate-mark reaching almost up to the equator. × 100, slide no. 8197.
7. *Verrutriletes* sp. megaspore in dry condition. × 100, slide no. 8198.

PLATE 8

1. *Erlansonisporites indicus* sp. nov. megaspore after maceration showing well-marked, slightly sinuous triradiate-mark and diaphanous appendages. × 100, slide no. 8199.
2, 5-7, 9. *Minerisporites mineri* (Dev) comb. nov. 2, 5. Two megaspores in dry condition showing the slightly sinuous triradiate-mark extending up to the equatorial margins, and a reticulate exosporium. × 100; 7, 6. Photomicrographs of the above two megaspores after maceration. × 100, slide nos. 8200, 8201; 9. A macerated megaspore. × 100, slide no. 8202.
3, 4, 8, 11, 12. *Minerisporites auriculatus* Singh, Srivastava & Roy, 1964. 3. A megaspore in dry condition. × 100, slide no. 8203; 4, 11. A megaspore in dry (× 100) and in macerated (× 150) condition, slide no. 8204; 8. A macerated megaspore. × 100, slide no. 8205; 12. Macerated stage of a megaspore. × 100, slide no. 8190.
10. *Umiaspora bosei* Singh, Srivastava & Roy, 1964. Holotype. × 100, slide no. 1750.

PLATE 9

1-2. *Minerisporites cutchensis* Singh, Srivastava & Roy, 1964. × 100, slide nos. 1744, 1768.
3. *Minerisporites auriculatus* Singh, Srivastava & Roy, 1964, Lectotype. × 100, slide no. 1753.
4. *Verrutriletes* sp. Macerated stage of the megaspore illustrated in Pl. 7, fig. 7. × 100, slide no. 8198.
5. *Minerisporites auriculatus* Singh, Srivastava & Roy. Scanning electron micrograph of a megaspore. × 100, negative no. 8417.
6. *Paxillitriletes battenii* sp. nov. Megaspore in dry condition. × 100 slide no. 8206.

PLATE 10

1. *Valvisisporites minor* Singh, Srivastava & Roy, 1964. × 200, slide no. 1692.
2. *Minerisporites dharesiensis* sp. nov. The holotype showing cushioned mesosporium. × 100, slide no. 8207.
3-5. *Paxillitriletes battenii* sp. nov. 3. Holotype of the species in dry condition showing a narrow equatorial zona, trilete laesurae assciated with long, branched or unbranched, flattened appendages and exosporium possessing straight, filamentous processes on both sides. × 100, preserved in macerated state, slide no. 8208; 4. A megaspore after maceration showing comparative short filaments on the exosporium. × 100, slide no. 8209; 5. Scanning electron micrograph of a part of megaspore showing nature and attachment of filamentous processes. × 300, negative no. 2800.

PLATE 11

1, 2. *Dijkstraisporites filiformis* Singh, Srivastava & Roy, 1964. 1. Megaspore in macerated condition showing a broad zona and filiform appendages on the central body. × 50, slide no. 1698; 2. Part of a megaspore enlarged showing delicate nature of filiform appendages and formation of reticulum (superficial) at the bases of the appendages (i.e. on central body of the spore). × 150, slide no. 8215.
3-6. *Minerisporites reticulatus* (Singh *et al.*) comb. nov. Spores after maceration. 3. × 200, slide no. 1705; 4. Holotype. × 100, slide no. 1727; 5. × 100, slide no. 1707; 6. × 150, slide no. 1707.
7. *Paxillitriletes cutchensis* Singh, Srivastava & Roy, 1964. Holotype. × 100, slide no. 1736.

PLATE 12

1, 2. *Dijkstraisporites triangulatus* Singh, 1964. 1. Megaspore after maceration showing deeply reticulate central body, ill-developed zona and fairly broad triradiate-mark. × 100, slide no. 8210; 2. Enlarged view showing details of the reticulum. × 150.
3-5. *Dijkstraisporites grantii* sp. nov. 3. Holotype showing triangular central-body with well-developed zona. × 100, slide no. 8211; 4, 5. Central-body of the megaspore showing rugulate exine with spinate sculpture. × 150.
6. *Saccarisporites* sp. Megaspore in macerated condition. × 100, slide no. 1706.

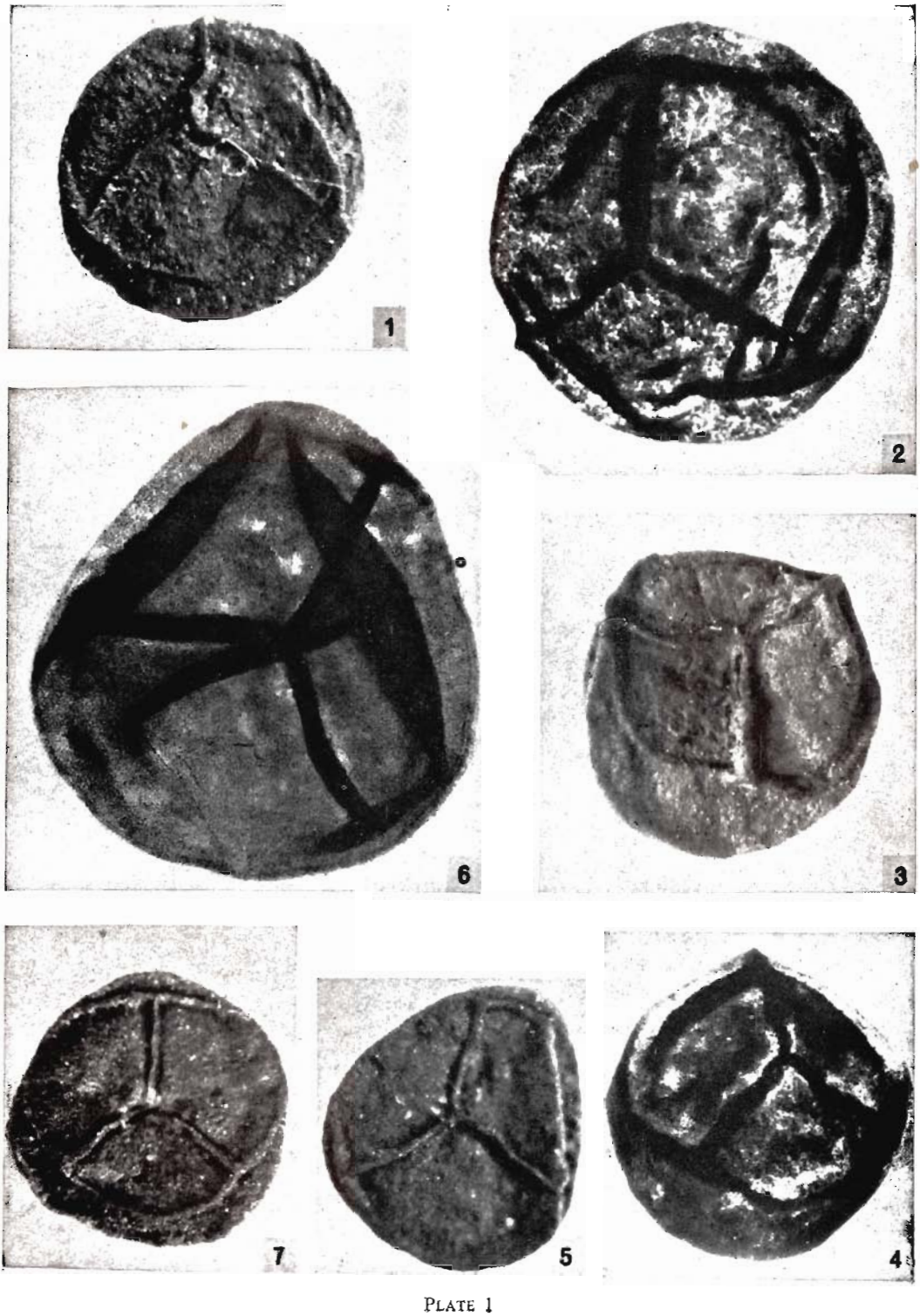
PLATE 13

1, 2. *Verrutriletes stoliczkae* sp. nov. 1. Holotype in dry condition. × 100; 2. The same megaspore after maceration showing the presence of three layers and the evenly verrucate exosporium. × 100, slide no. 8212.
4. *Horstisporites* sp. Megaspore. × 150, slide no. 8213.

5, 6. *Verrutriletes* sp. Megaspore in macerated condition showing nature of attachment of wart-like structures, supposed to be due to fungal infection, 5. × 50, 6.× 200, slide no. 8213.

3, 7-8. Megaspore type A. 7. Spore in dry condition showing more or less circular outline, triradiate-mark not discernible. × 100; 8. The same spore after maceration showing thick exosporium with broad-based spines at the equatorial margin and coarsely rugulate exosporium. × 100; 3. Part of macerated spore enlarged to show the thickness and nature of rugulate ornamentation of exosporium. × 150 (spore consumed during maceration), negative nos. 7371, 7289 and 7369.

9. Megaspore type B. Showing finally reticulate exosporium and comparatively small mesosporium. × 150, slide no. 8214.



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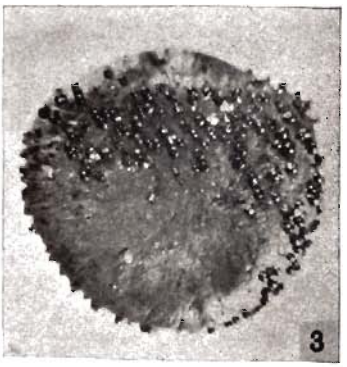

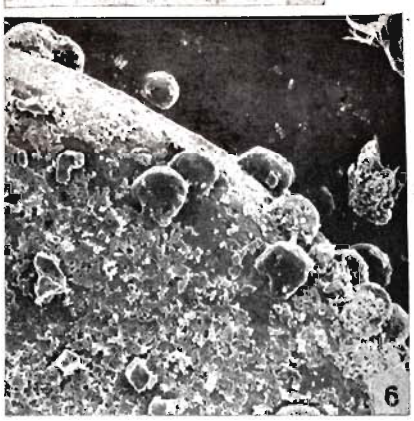

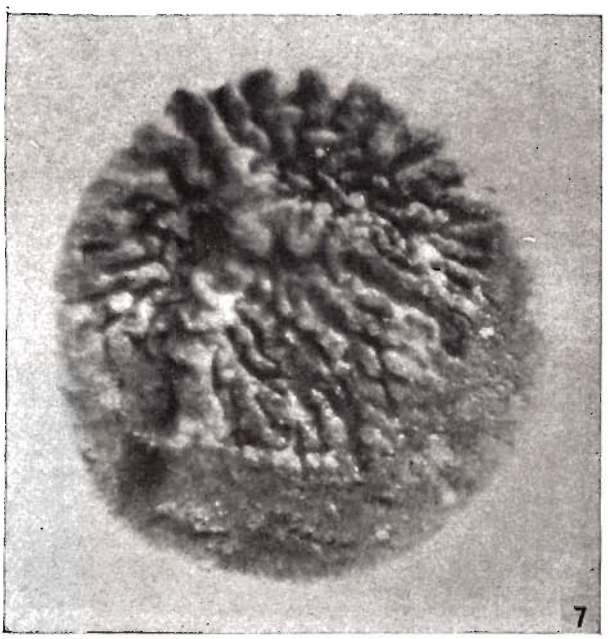

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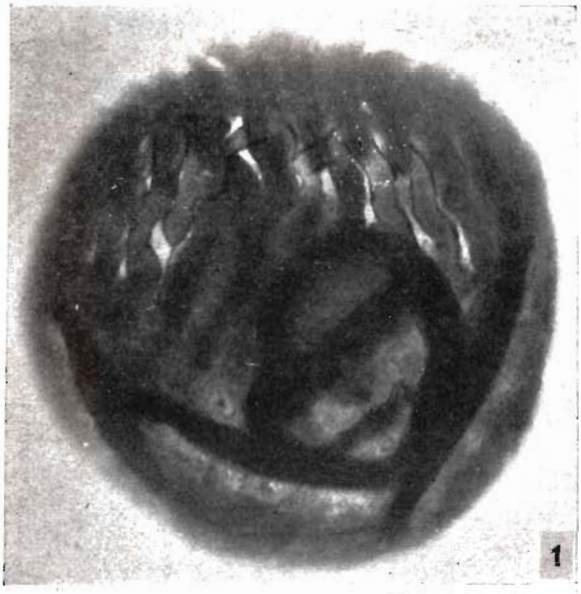

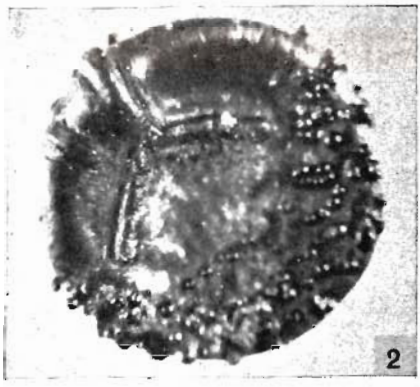

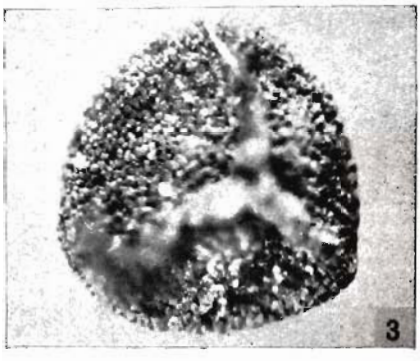

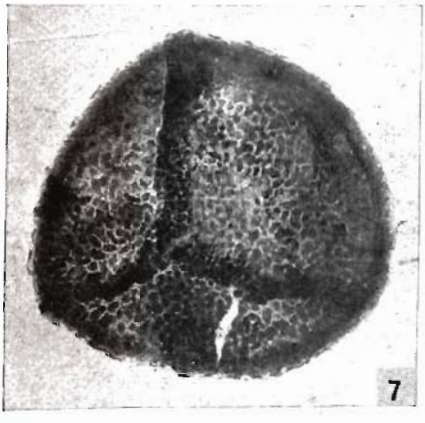

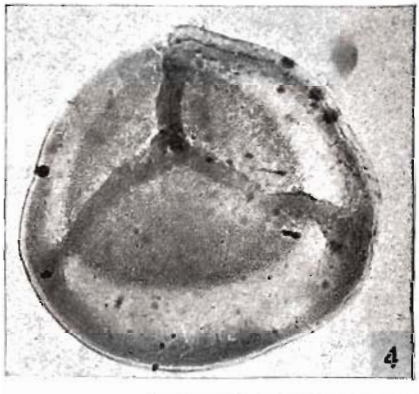

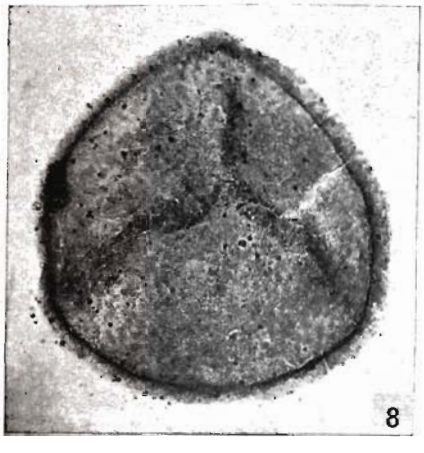

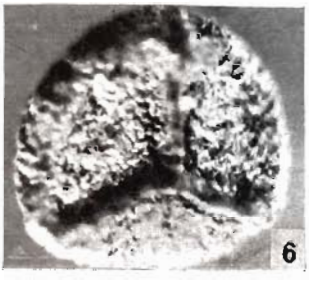

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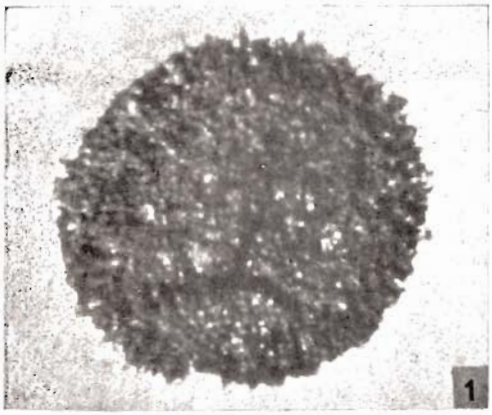
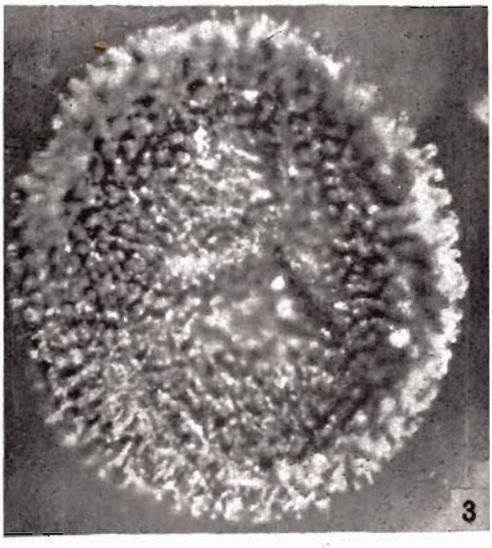
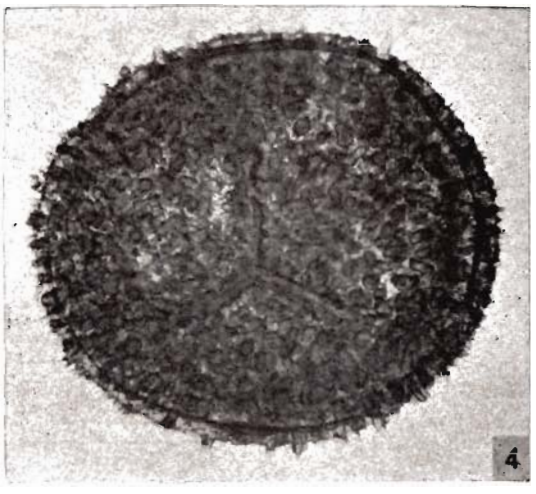
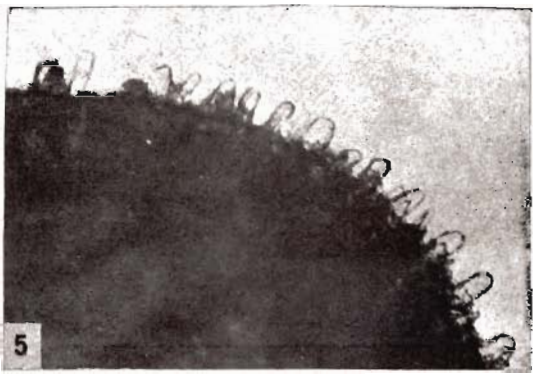








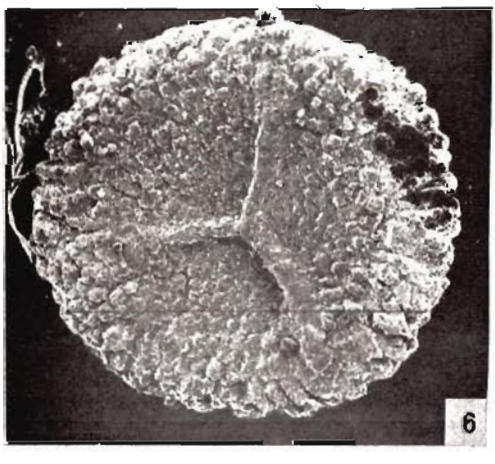


PLATE 4

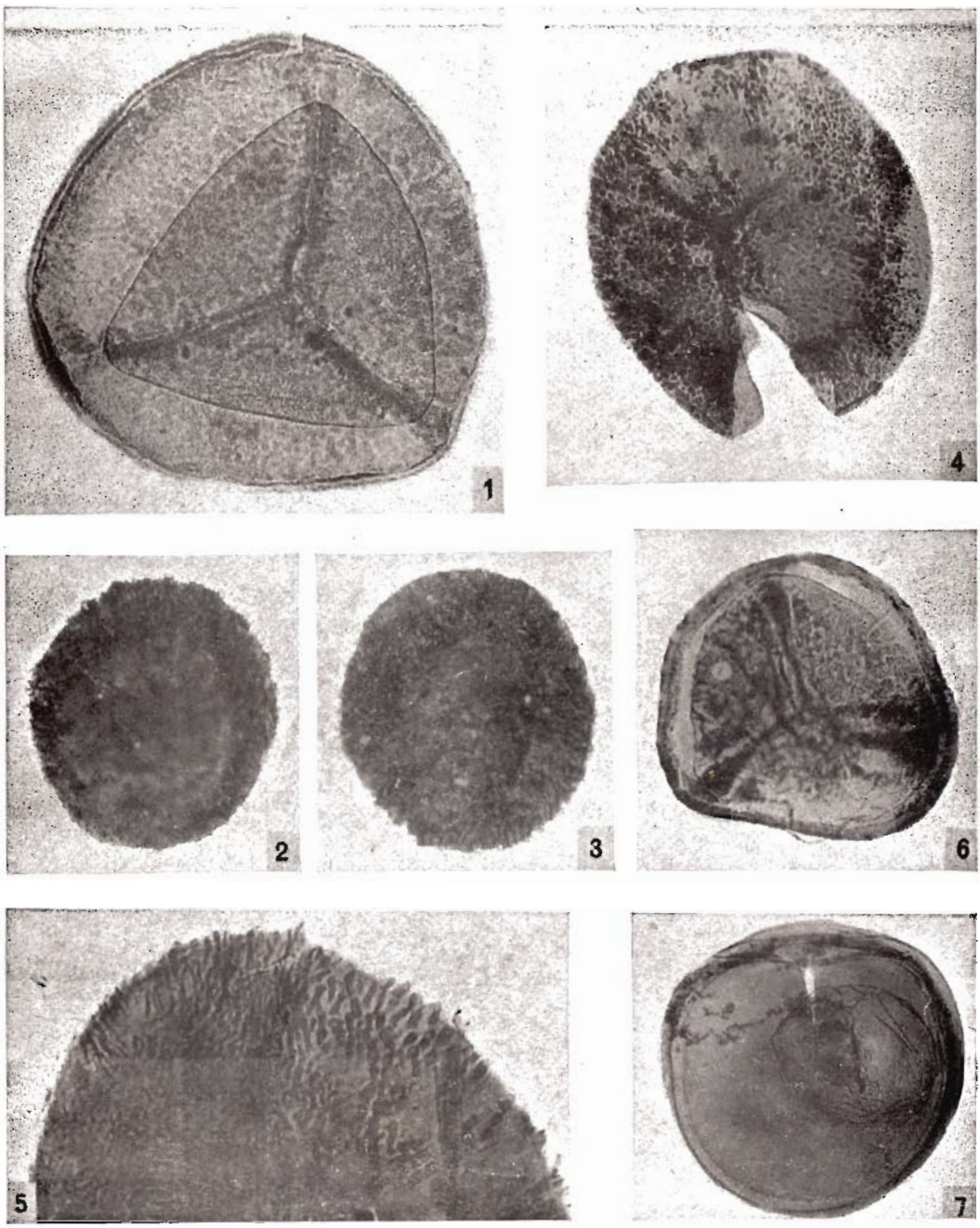
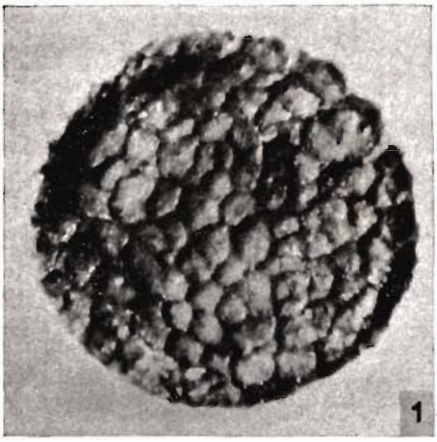
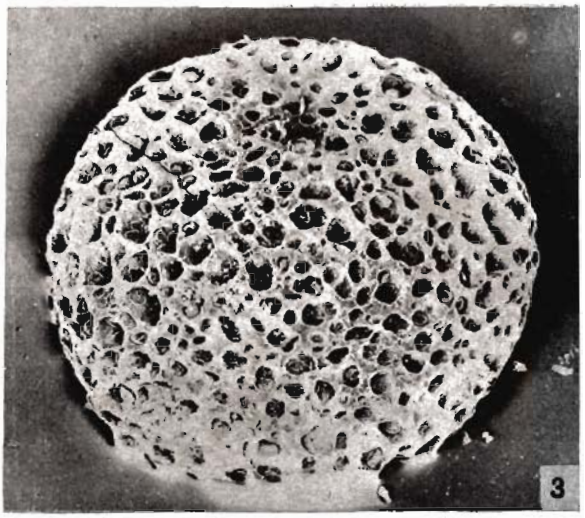


PLATE 5





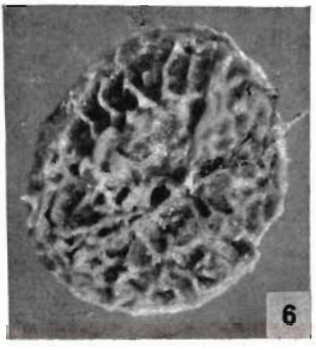
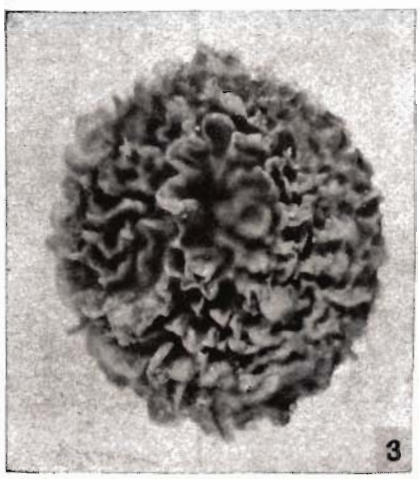
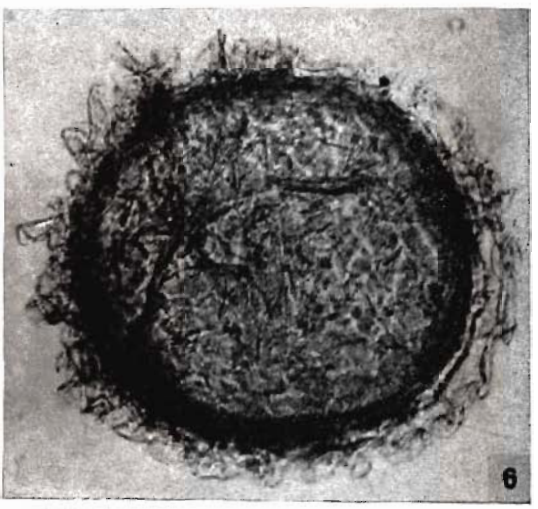
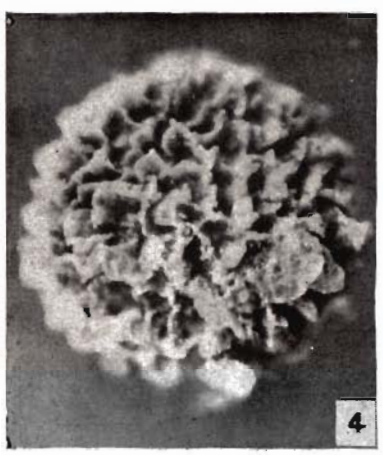


PLATE 6







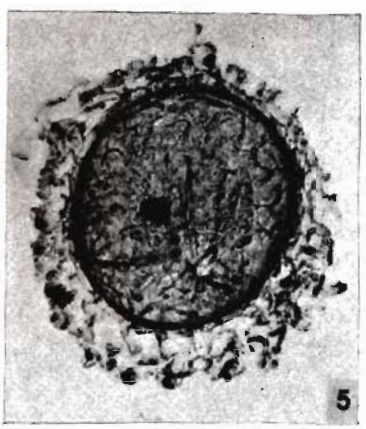


PLATE 7

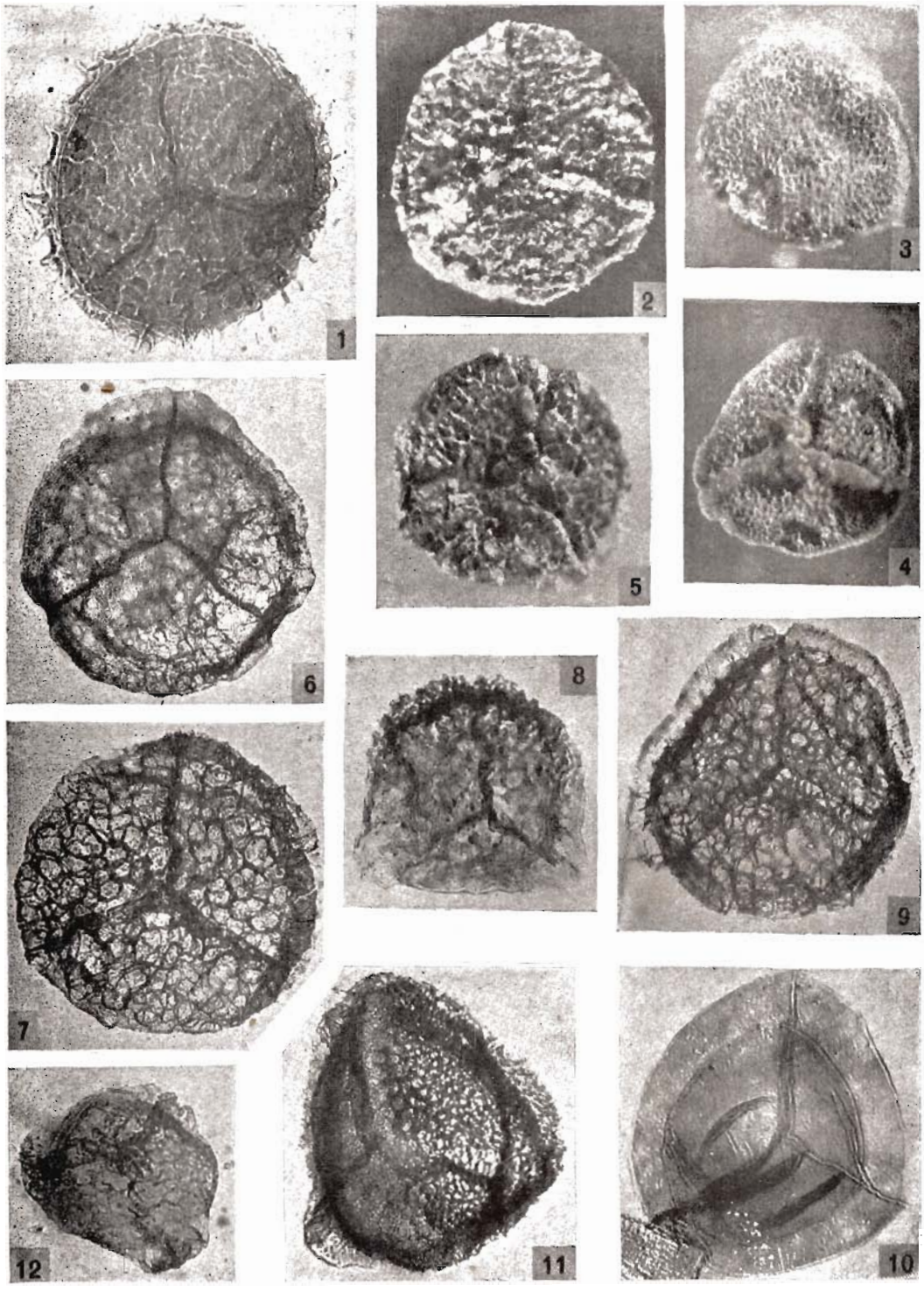
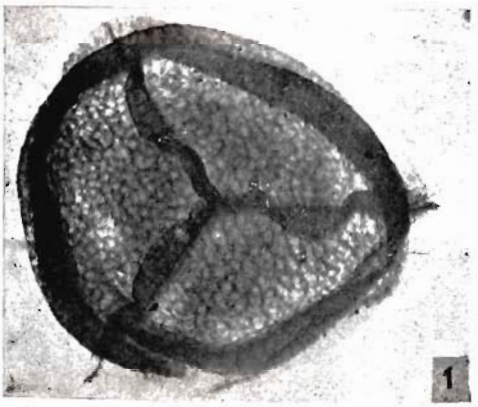
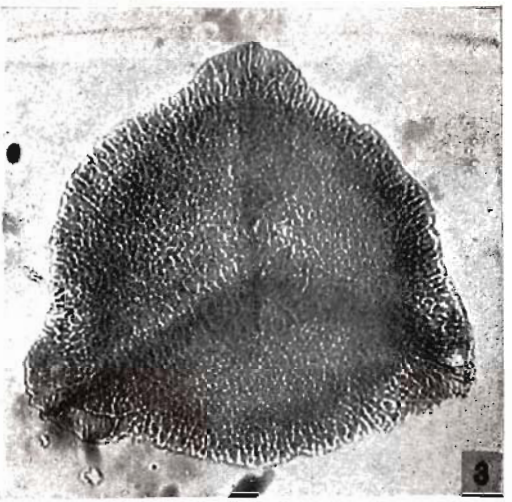
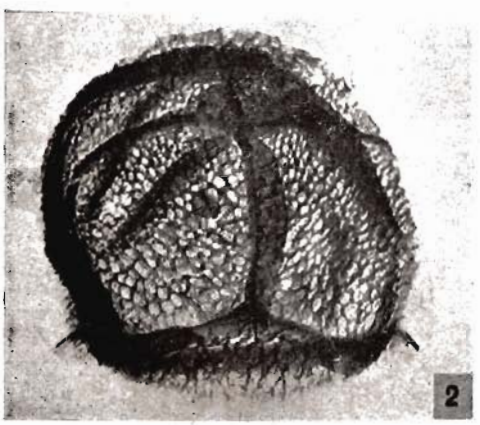
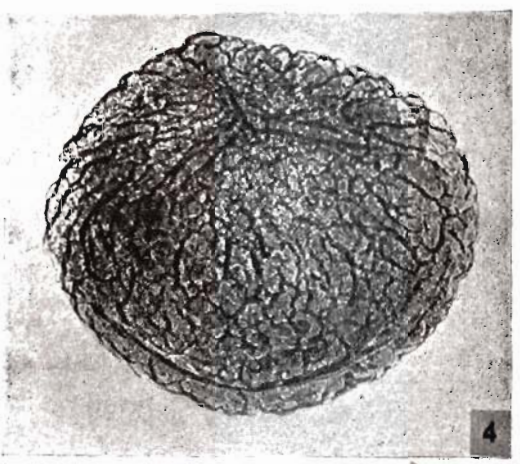


PLATE 8









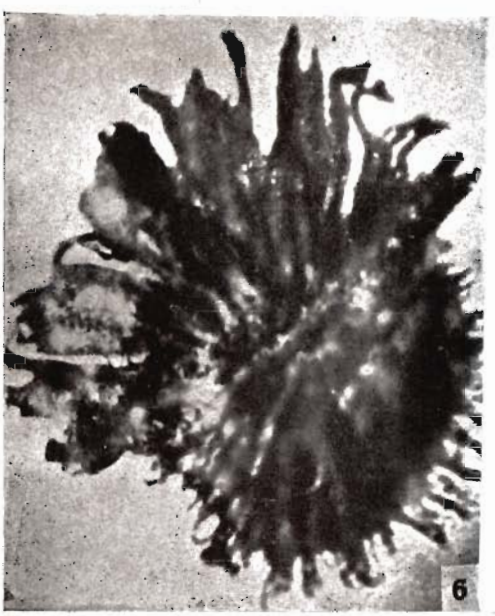
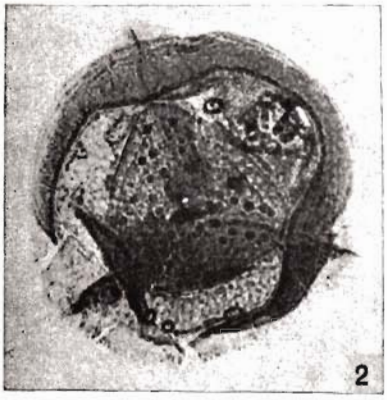
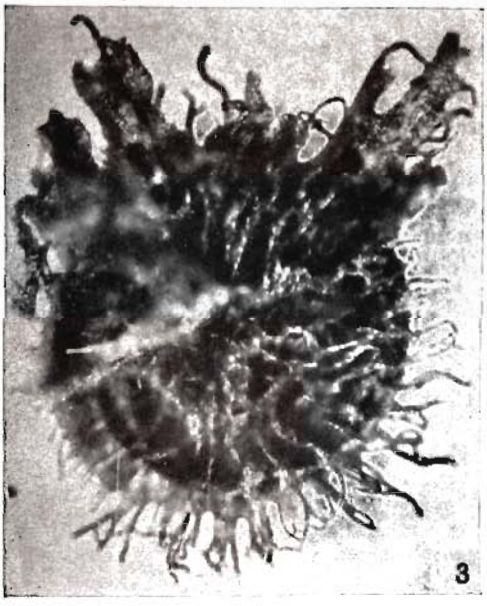


PLATE 9





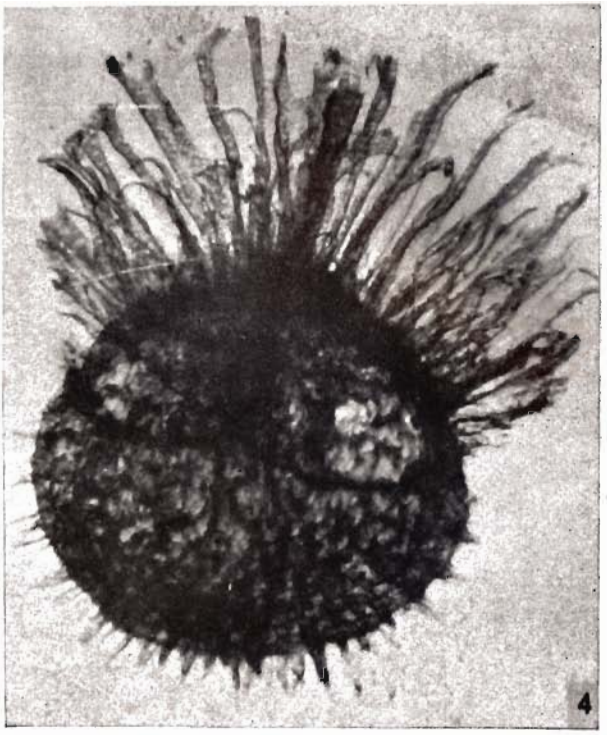
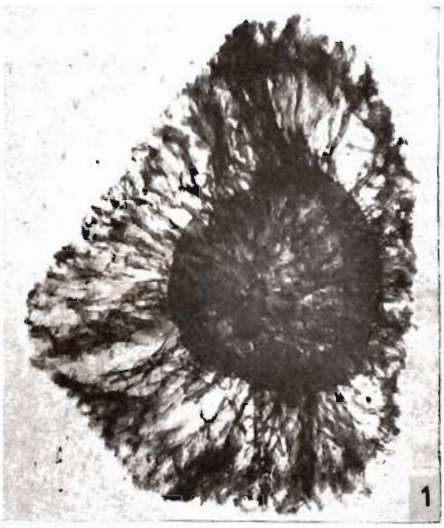
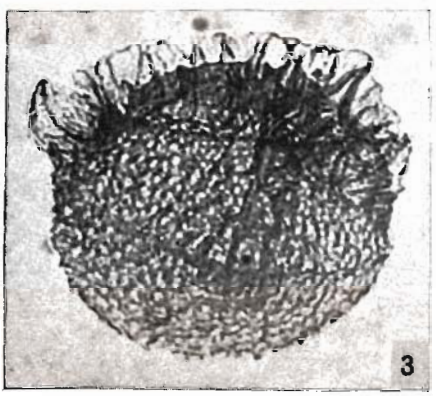


PLATE 10





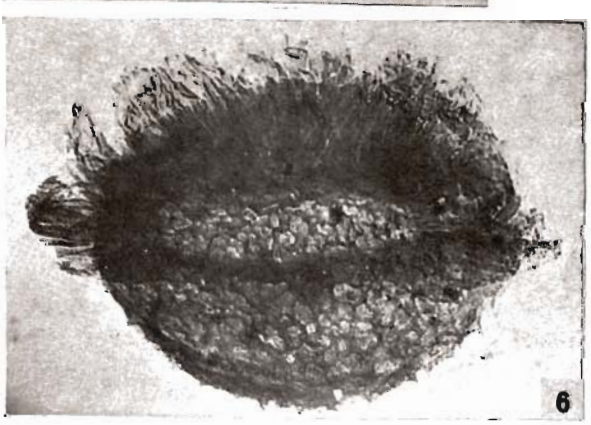
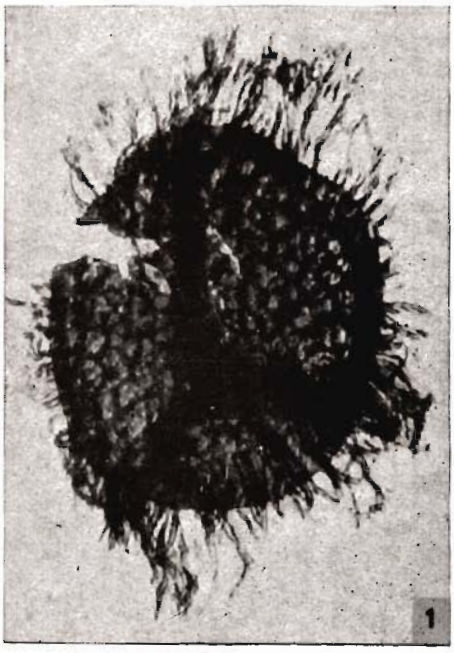
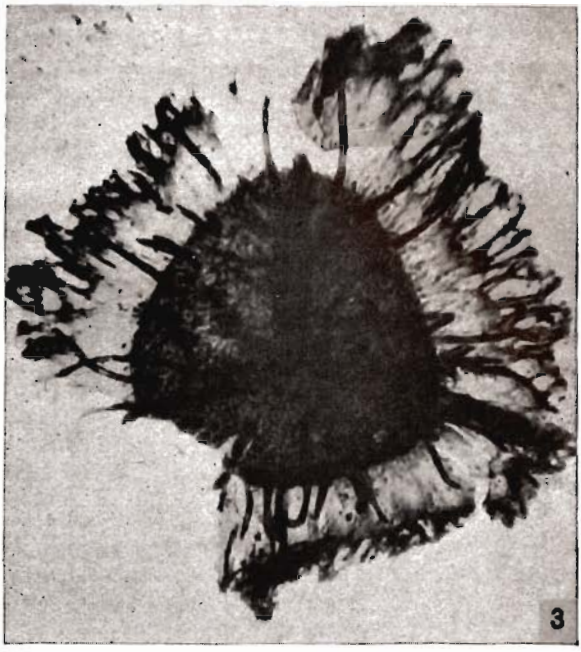
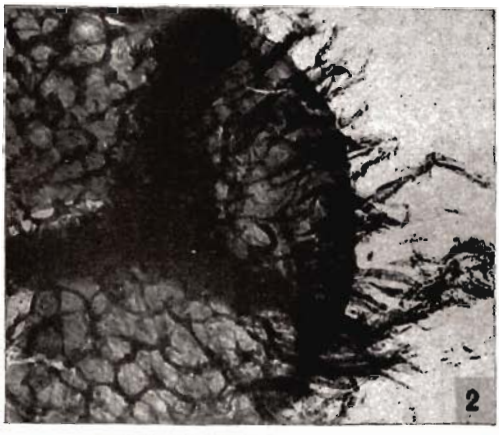


PLATE 11







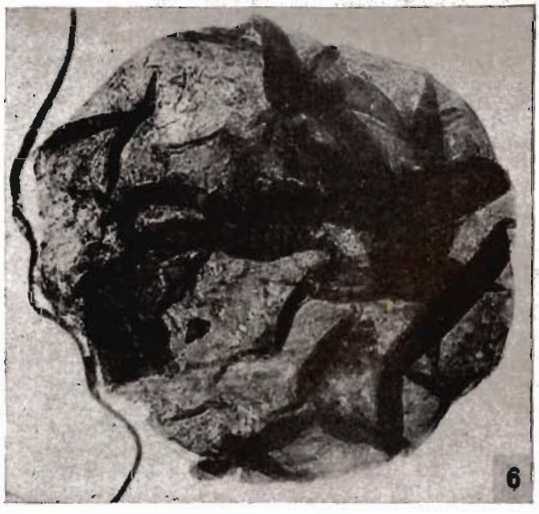


PLATE 12

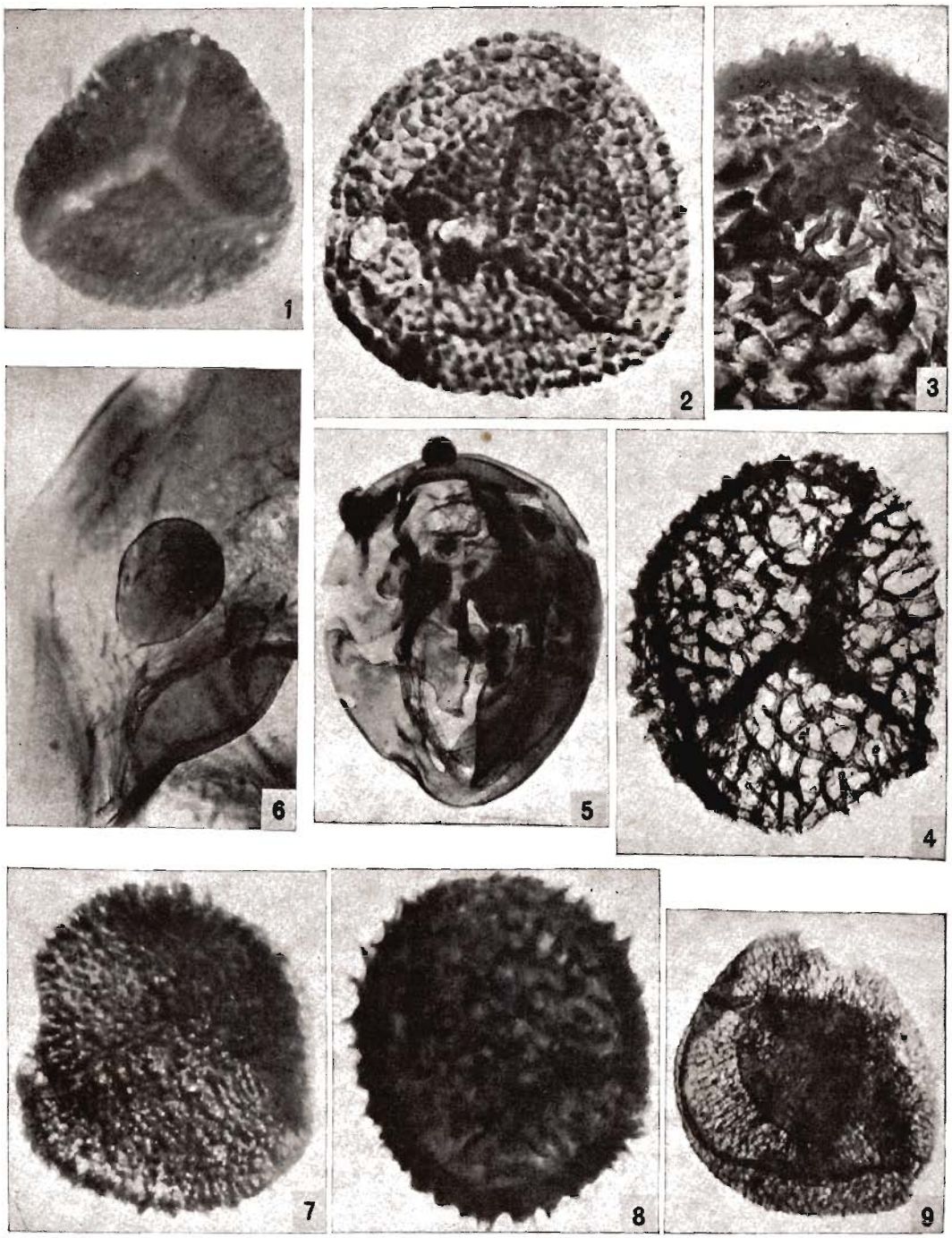


PLATE 13