

# Diporocolpis : A new type of aperture from the Early Eocene sediments of Rajasthan, India

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Three Early Eocene pollen types, viz., *Piladiporocolpites*, *Psiladiporocolpites* and *Retidiporocolpites* having diverse morphological characters but all possessing a characteristic type of aperture called 'Diporocolpis' are described from the bore-hole core no K12, drilled by the MECL around Kuchaur-Benia area, Bikaner District, Rajasthan. The 'Diporocolpis' type of aperture, proposed as a new name, is characterized by the presence of two equatorial pores connected by a colpus. In some genera, the margin of aperture is spinose, whereas in others the spines are absent. The exine is variously sculptured or structured.

**Key-words**—Palynology, Diporocolpate pollen, Palana Formation, Early Eocene, Rajasthan (India).

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## सारांश

डाइपोरोकोल्पिस : राजस्थान (भारत) के प्रारम्भिक आदिनूतन अवसादों से एक नये प्रकार का छिद्र

रंजीत कुमार कर

राजस्थान में बिकानेर जनपद में कुचौर-बेनिया क्षेत्र के आस-पास एम-इ-सी-एल० द्वारा किये गये वेध-छिद्र क्रोड संख्या के-12 से विभिन्न आकारिकीय लक्षणों से युक्त परन्तु सभी एक लाक्षणिक प्रकार के छिद्र "डाइपोरोकोल्पिस" से युक्त तीन प्रारम्भिक आदिनूतन परागकणों अर्थात् पाइलाडाइपोरोकोल्पाइटिस, साइलाडाइपोरोकोल्पाइटिस एवं रेटिडाइपोरोकोल्पाइटिस का वर्णन किया गया है। डाइपोरोकोल्पिस प्रकार का छिद्र, जिसको एक नया नाम प्रस्तावित किया गया है, एक विदरक से संयोजित दो मध्यरेखीय छिद्रों से अभिलक्षणित है। कुछ प्रजातियों में छिद्र का किनारा कटक की है जबकि अन्यो में कटक अनुपस्थित है। इनका बाह्यचोल विभिन्न संरचनाओं से अलंकृत है।

THE apertural types of spores and pollen grains are very conservative and only few forms of apertures are repeatedly found in all the plant groups. According to Nair (1967) there have been three independent lines of apertural evolution in plants along the lines of Pteridophyta, Gymnospermae and Angiospermae. The trilete, tetrahedral spores are found in the earliest known vascular plants; from the basic trilete form evolved monolete forms with bilateral shape in Pteridophyta, the monocolpate bilateral forms in the Gymnospermae and an array of sporomorphs with a variety of apertures in Angiospermae from this type.

Wodehouse (1936) thought that the monocolpate pollen grains found in many gymnosperms which with the passage of time turned to be more detrimental than beneficial and gave rise to other forms of aperture by modification, protection, reduction or elimination.

Kuprianova (1967) maintained that the fissurate type of aperture is more primitive than those of monocolpate type, because in this type the fissures are not covered

by any membrane. She assumes that in course of evolution the large fissures were covered by a membrane and they transformed into furrows. A general tendency of reduction of furrows leads to the formation of pores.

Meeuse (1965) and Sowunmi (1968) advocate the archaic nature of the monocolpate aperture and trace its origin to the Palaeozoic Ginkgoales. It serves both as hermomegathy and germinal exit and is quite common in monocotyledons.

Sowunmi (1968) made diagrammatic representation of the five possible trends in apertural development. In figure 8 (p. 47) she depicted diporate pollen with a colpoid streak. This is a hypothetical case and according to her a transition from a colpus to two pores appears to be clearly exhibited by the pollen grains of *Daemonorops sparsiflorus*. The pollen in this species has two equatorial pores. Connecting the two pores is a distinct narrow area probably the central part of a disappearing colpus. She cautions that this colpus is

really not an aperture but a thin area delimited or bounded by the exine. She thinks that it very probably represents a colpus on its way out.

Thanikaimoni (1970) rearranged the diagram represented by Sowunmi for the apertural evolution but does not agree with her for the supposed evolution of biporate grain through the transitional phase of disappearing colpus as exemplified by her in *Daemonorops sparsiflorus*. Thanikaimoni (1970) opines that the disappearing colpus in question is nothing but a fold and there is no connecting colpus whatsoever. Absence of this type of aperture in the extant angiosperms naturally leads to the assumption that such apertural form never existed in living as well as fossil angiosperms.

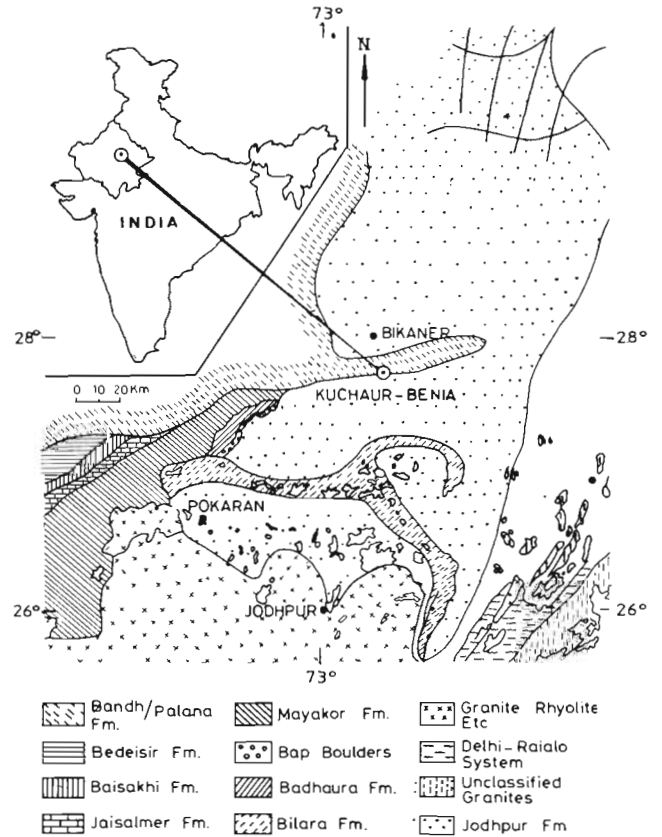
**MATERIAL AND METHOD**

A bore hole core no. K12 about 140 m deep drilled by the MECL at Kuchaur-Benia area in the district of Bikaner, Rajasthan (Text-figure 1) was earlier studied for palynological fossils. Kuchaur-Benia area is approximately 30 km south-west of Bikaner by the Bikaner-Nagaur road. The area is covered by sand and sand dunes and no outcrop is visible in the neighbourhood. The lithology comprises mostly of sandstone and shale with occasional presence of lignite. The lowermost unit (135-140 m) consisting of white sandstone is overlain by carbonaceous shale (121-134 m) with lignitic bands. White sandstone found in between 99-120 m is again overlain by carbonaceous shale (70-98 m) with thin bands of lignite. Above it, there is a thick deposit of (35-70 m) yellow, coarse sandstone (Text-figure 2). This is topped by unconsolidated layers of pebbles, kankars and sand. The palynological fossils were recovered at the depth of 134 m, 125 m, 121 m, 98 m, 97 m, 90 m, 85 m and 80 m.

The samples were treated with nitric acid followed by a wash with 5 per cent potassium hydroxide solution. The slides were prepared in polyvenyl alcohol/and mounted in canada balsam. The palynoassemblage is dominated by *Proxapertites operculatus* van der Hammen 1956, *Proxapertites cursus* van Hoenkken-Klinkenberg 1966, *Neocouperipollis kutchensis* (Venkatachala & Kar) Kar & Kumar 1986, *Lakiapollis ovatus* Venkatachala & Kar 1969, *Margocolporites tsukadai* Ramanujam 1966, *Tricolpites reticulatus* Cookson 1947, etc. The slides have been deposited at the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

**PREVIOUS PALYNOLOGICAL WORK**

Rao and Misra (1949) recorded *Botryococcus braunii* from Palana Formation. Rao and Vimal (1950) described many palynofossils as type 1, type 2, etc. Sah and Kar



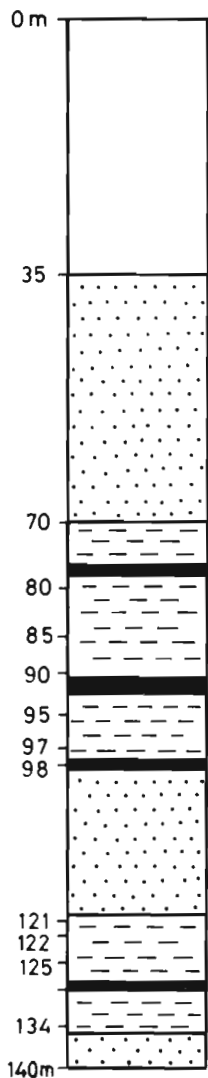
**Text-figure 1**—Geological map of Kuchaur-Benia area (after Shrivastava, 1971).

(1974) detailed 8 genera and 11 species of pteridophytic spores, 24 genera and 36 species of angiospermic pollen from Palana. Besides, they described a number of taxa belonging to algal and fungal entities.

**Geology**—The West Rajasthan Shelf according to Das Gupta (1973) comprises a few sedimentary basins separated from each other by basement ridges. Blanford (1877), Oldham (1886), La Touche (1902), Bhola (1940), Jacob and Sastri (1950), Singh (1951, 1952, 1953, 1971), Ghosh (1962), Chatterjee (1960), Narayanan *et al.* (1961), Khosla (1967, 1968), Sigal *et al.* (1971), Shrivastava (1971), Das Gupta (1977), Pareek (1981), Singh (1984) and others worked on the various geological aspects of this basin.

The Bikaner-Nagaur basin which is a part of the West Rajasthan Shelf, is delimited to S and SW by the Pokaran-Nachna uplift, to the east by the western spurs of the Aravalli mountains and to the north by the subsurface Delhi-Saragoda ridge. Das Gupta (1977) opines that the North Bikaner High divides this into Nagaur sub-basin to the east and the Bikaner sub-basin to the west.

Shrivastava (1971) advocated the following rock stratigraphic classification for the Cenozoic rocks of the basin.



**Text-figure 2**—Litholog of the bore hole core no. K12, drilled by the MECL.

#### Quaternary

Mar Formation—Dirty white, brown, ferruginous, medium to coarse grain, gritty and conglomeratic, current bedded sand with minor, variegated shale and clay (560 ft thick).

#### Tertiary

Jogira Formation—Nummulitic yellow limestone, marl test beds, foraminiferal limestone and grey to yellow Fuller's earth (520 ft thick).

Palana Formation—Variegated clays, interbedded nummulitic limestone and marls with dark to grey sticky clays and minor sandstones; lignite at places.

Das Gupta (1977) correlates the lignite bearing Palana Formation with the Thumbli Member of the Akli Formation in the Barmer Basin. He also introduced Kolayet Formation for a sequence of impure bentonitic clay and a bioclastic limestone containing *Assilina daviesi*, *A. granulosa*, etc. lying above the Palana Formation. The Quaternary age assigned to Mar Formation by Shrivastava is doubted by Das Gupta (1977) as Singh (1952) described some Kirthar fossils from this formation.

#### DIPOROCOLPATE TYPE OF POLLEN

Three pollen types having diverse morphological characters but with the same type of diporocolpate aperture have been encountered in the assemblage. For this type of aperture a new term, viz., Diporocolpis is proposed. It is characterized by the presence of two equatorial pores connected by a colpus. In some genera the pore and colpus margin are ornamented with spines where in others they are smooth. The exine of the diporocolpate form is variously ornamented. They may be laevigate, pilate or reticulate.

Observing this diverse type of sculptural patterns with diporocolpus type of aperture the term Diporocolpis is introduced here. The author feels that in future many other forms would be known and like Normapolles it would eventually turn into an important morphological group.

Diporocolpis opens a new vista of pollen morphology and also helps to understand the evolutionary tendencies. According to Nair (1965) of the various morphological characters of pollen those of apertures are considered as primary, of exine ornamentation pattern as secondary and others, viz. size, shape exine strata as tertiary. With the initiation of pore/oral at the terminal margin of the colpus, it was not only emancipated of the long monotonous monocolpate form which it inherited from the Palaeozoic Cordaitales but also opened new potentialities for forming diversified apertural types. Once a composite aperture was obtained, new forms of this type could be developed by means of permutation and combination. The hypothetical form visualized by Sowunmi (1968) has been ultimately recognized in the Early Tertiary sediments of India. It is, however, a mystery why this pollen type disappeared in the younger horizons and is unrepresented in the modern angiosperms. As the two pores and colpus/oral were joined together, it was perhaps a hermomegathic problem because such a long open space was hazardous to protect the pollen from desiccation. Diporate, diporocolpate and dicolporate forms are rare in fossil as well as in living forms. It seems that nature did not patronize these forms due to some reasons unknown to us.

The evolution of diporate forms from Diporocolpis form of pollen could easily be traced by the disappearance of colpus. However, dicolporate forms could be visualized by the restricted occurrence of colpus at two ends. More pore or colpi could be developed by breaking down of the existing colpus or division of pores. With the introduction of diporocolpis type of pollen diversity of apertural form could be obtained within a short span of time breaking down the monotony of monocolpate form. It does not, however, mean that monocolpate form of aperture is not a suitable one. Judging its presence in most of the monocots and some of the dicots it goes without saying that it is still an effective type of aperture. Evolution of porate or colporate forms from this basic type was perhaps a necessity for better adjustments towards germination and dissemination.

### SYSTEMATIC DESCRIPTION

#### Genus—*Piladiporocolpites* gen. nov.

Type species—*Piladiporocolpites caratinii* sp. nov.

*Generic diagnosis*—Pollen grains elliptical to oval, 48-60 × 35-45 μm. Diporocolpate, pores big, distinct, sometimes looking like ora, placed opposite to each other on the equator, pore margin spinose, pores connected by a colpus, colpus margin spinose. Exine 2-4 μm thick, pilate, pila 3-5 μm long, with narrow base and swollen tip, sparsely placed, interpilae exine laevigate.

*Remarks*—*Piladiporocolpites* is not comparable to any known fossil or living genera in its apertural condition. The known fossil genera are either monocolpate, e.g., *Neocouperipollis* (Venkatachala & Kar) Kar & Kumar 1986; *Longapertites* Guzmán 1967, *Palmaepollenites* Potonié 1951, etc. or diporate, viz., *Diporoconia* Frederiksen *et al.* 1985, *Diporisporites* van der Hammen 1954 and *Banksiaeidites* Cookson 1950.

The diporocolpate pollen are quite common in the present samples and contribute up to 8 per cent of the total assemblage. So they do not seem to be aberrant pollen.

#### *Piladiporocolpites caratinii* sp. nov.

P1. 1, figs 1-6

*Holotype*—Pl. 1, fig. 1; size 50 × 38 μm; Slide no. BSIP 11272, U20/4.

*Type locality*—Bore hole core no. K12, depth 134 m, Palana Formation, Early Eocene, Bikaner District, Rajasthan.

*Description*—Proximo-distally flattened specimens oval-elliptical, meridionally preserved specimens mostly subcircular-circular in outline, 48-55 × 37-48 μm.

Diporocolpate aperture distinct in proximo-distally flattened specimens, obscure in others, pores and colpus placed in a line in meridionally preserved specimens, margin of pore spinose, spines 2-4 μm long, delicate. Colpus distinct, uniformly broad, connects each pore at equator, colpus margin also spinose, spines 2-4 μm long, slender. Exine strongly built, 2-4 μm thick, pilate, pila well developed, sparsely placed, 2-5 μm long, narrow at base but swollen at tip, mostly adpressed to provide circular warts like structure on the exine. Interpilae exine laevigate.

*Derivation of name*—After Dr C. Caratini of French Institute, Pondicherry

#### Genus—*Psiladiporocolpites* gen. nov.

Type species—*Psiladiporocolpites pachyexinus* sp. nov.

*Generic Diagnosis*—Pollen grains generally oval-elliptical, 42-55 × 33-47 μm. Diporocolpate, pores equatorial, distinct, big, margin spinose, spines delicate. Colpus distinct, connecting two pores, margin spinose, occasionally folded. Exine 2-5 μm thick, laevigate.

*Comparison*—*Piladiporocolpites* though resembling the present pollen type is readily differentiated by its laevigate exine.

#### *Psiladiporocolpites pachyexinus* sp. nov.

P1. 1, figs 7-10, 16-17

*Holotype*—P1.1, fig. 7; size 45 × 36 μm; Slide no. 11273, V42.

*Type locality*—Bore hole core no. K12, depth 134 m, Palana Formation, Early Eocene, Bikaner District, Rajasthan.

*Description*—Proximo-distally flattened specimens oval-elliptical, meridionally preserved specimens subcircular, 45-62 × 35-45 μm. Diporocolpate, pores at equatorial margin big, distinct, margin spinose. Exine 2-5 μm thick, laevigate.

#### Genus—*Retidiporocolpites* gen. nov.

Type species—*Retidiporocolpites excellensus* sp. nov.

*Generic Diagnosis*—Pollen grains oval-elliptical in shape, 35-60 × 30-42 μm. Diporocolpate, pores equatorially placed, big, prominent, colpus distinct, sometimes obscured by ornamentation, extending from one margin to other and connecting two pores. Exine 1-2.5 μm thick, tectate, columellate, sexine slightly thicker than nexine, reticulum well developed, muri thick, lumina of different sizes and shapes, smaller sizes near pore margin.

*Comparison*—*Piladiporocolpites* though comparable to the present genus is readily separated by its pilate sculpture and presence of spines along the margin of apertures. *Psiladiporocolpites* is also diporocolpate but is psilate. *Retidiporocolpites* proposed here is distinguishable from all the genera by its diporocolpate aperture, psilate apertural margin and its reticulate structure.

*Retidiporocolpites excellensus* sp. nov.

P1. 1, figs 11-12

*Holotype*—P1.1, fig. 11; size  $37 \times 33 \mu\text{m}$ ; Slide no. 11276, M24/3

*Type locality*—Bore hole core no. K12, depth 134 m, Palana Formation, Early Eocene, Bikaner District, Rajasthan.

*Description*—Pollen grain oval-elliptical in shape,  $33-42 \times 30-35 \mu\text{m}$ . Diporocolpate, one pore at each equator, very big, margin thin and smooth. Colpus not very distinct, obscured by reticulation, extending from one end to other and connecting two pores. Exine  $2.5 \mu\text{m}$  thick, tectate, columellate, sexine slightly thicker than nexine, reticulation broad, muri thick, lumina of different sizes and shapes.

*Retidiporocolpites* sp.

P1.1, figs 13-15

*Description*—Pollen grain elliptical,  $55 \times 35 \mu\text{m}$ . Diporocolpate, pore distinct, situated at equator, very big; colpus narrow, slit-like, extending one end to other and connecting two pores. Exine  $1.5 \mu\text{m}$  thick, reticulate, meshes small, less than  $1 \mu\text{m}$ .

*Comparison*—*Retidiporocolpites excellensus* is comparatively smaller in size and has broader reticulation.

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**PLATE 1**



(All photomicrographs are enlarged ca.  $\times 1000$  unless otherwise mentioned)

- 1-6. *Piladiporocolpites caratini* gen. et sp. nov., Slide no. BSIP 11272, U20/4, T28/1
- 7-10, 16-17 *Psiladiporocolpites pachyexinus* gen. et sp. nov., Slide

- 11-21 nos. BSIP 11273, V42, 11274, K33/4, 11273, Y9/4, 11275; D31/4.
- Retidiporocolpites excellensus* gen. et sp. nov., Slide no. BSIP 11276, M24/3.
- 13-15. *Retidiporocolpites* sp., Slide no. BSIP 11276, U38.

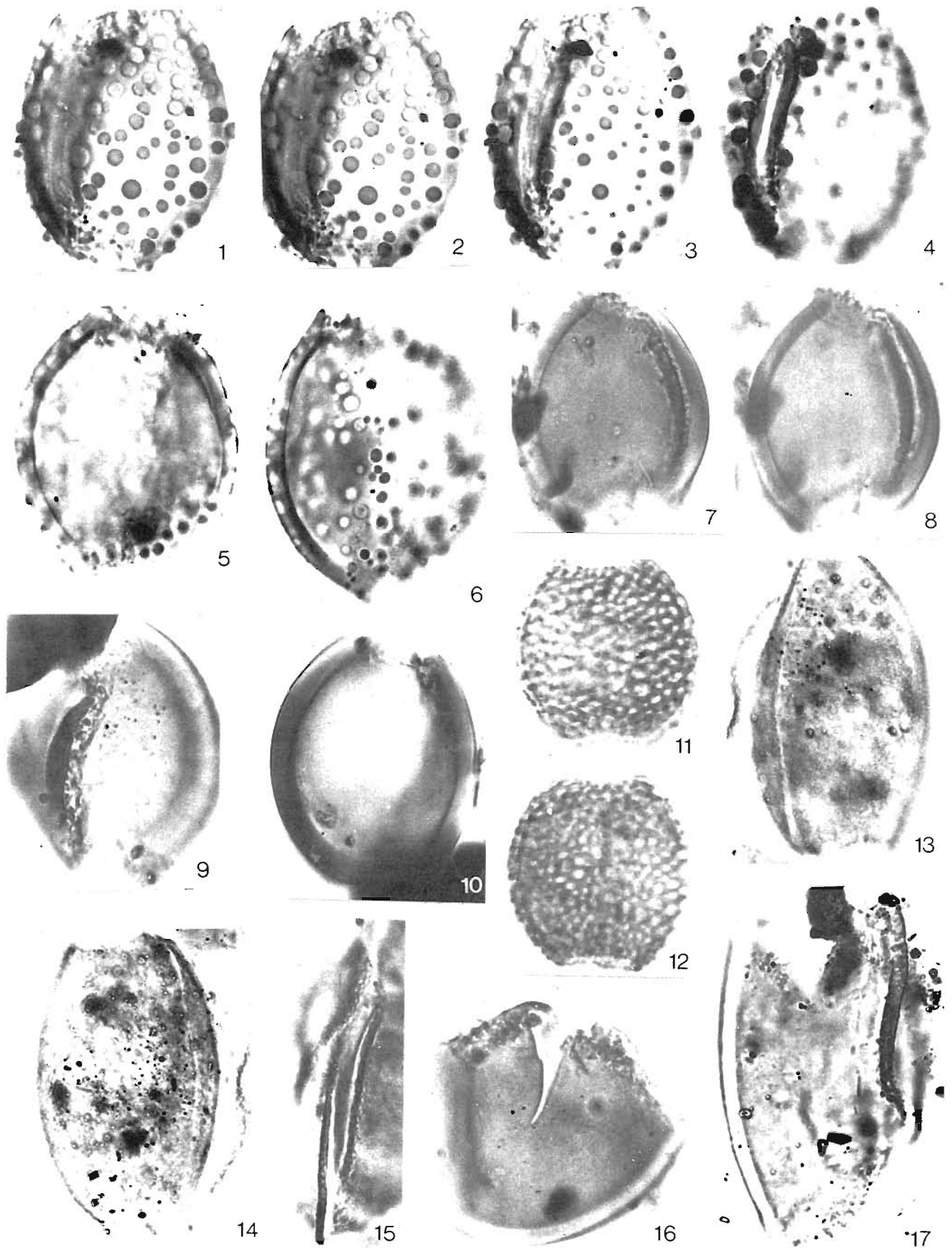


PLATE 1

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