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# UPPER PALAEOCENE CALCAREOUS NANNOPLANKTON FROM VRIDDHACHALAM AREA, CAUVERY BASIN, SOUTHERN INDIA*

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## ABSTRACT

Phytoplankton analysis of a 240 meter deep bore hole, located in the Gopurapuram Village north-east of Vriddhachalam in Cauvery basin, revealed the presence of calcareous nannofossils and dinoflagellate cysts in the basal sample, whereas the samples higher up in the sequence yielded only dinocysts.

The nannofossil assemblage includes eight genera containing 16 recognizable species. Out of these, *Discoaster multiradiatus* is discussed to mark the Standard Nannoplankton Zone NP 9 of Upper Palaeocene. The equivalent zone marker taxa of dinocysts, foraminifera and mega-algae also support an Upper Palaeocene age for these sediments.

*Key-words* — Calcareous nannoplankton, Cauvery basin, Upper Palaeocene, Southern India.

## सारांश

दक्षिणी भारत में कावेरी द्रोणी के वृद्धाचलम् क्षेत्र से उपरि पुरानूतन युगीन चूनामय परासूक्ष्म-जीवाश्म – कृष्ण प्रसाद जैन, राहुल गर्ग एवं दिनेश चन्द्र जोशी

कावेरी द्रोणी में वृद्धाचलम् के उत्तर-पूर्व में गोपुरापुरम गाँव में स्थित एक 240 मीटर गहरे वेध-छिद्र के आधारीय नमूनों के पादप-प्लवकीय विश्लेषण से चूनामय परासूक्ष्म-जीवाश्म एवं घूर्णीकशाभ पुटीयाँ उपलब्ध हुई हैं, जबकि इसी अनुक्रम के ऊपरी नमूनों से केवल घूर्णीकशाभ पुटीयाँ प्राप्त हुई हैं।

इस परासूक्ष्म समुच्चय में आठ प्रजातियों की 16 अभिनिर्धारणीय जातियाँ मिलती हैं। इनमें से डिस्कोएस्टर मल्टीरेडिएटस का उपयोग उपरि पुरानूतन के परासूक्ष्म-जीवाश्मीय मानक मंडल ऍन-पी० 9 को प्रदर्शित करने के लिए किया गया है। घूर्णीकशाभ पुटीयों, फ़ोरेमिनीफ़ेरों एवं गुरु-शैवालों के समतुल्य मंडलीय-चिन्हक वर्गकों से भी इन अवसादों की उपरि पुरानूतन आयु का पुष्टीकरण होता है।

## INTRODUCTION

THE marine fossiliferous rocks of Vriddhachalam area in South Arcot District, Tamil Nadu (Southern India) were described by Blanford (1862). He assigned Cretaceous age to these sediments, equivalent to the Ariyalur group of rocks of the neighbouring Trichinopoly area. The Palaeocene rocks in Vriddhachalam area were first recognized by Rajagopalan (1966-67). He found the lithology, microfauna and flora comparable with that of the Palaeocene, Upper Marl Unit of the Pondicherry Formation developed in Pondicherry area (Rajagopalan, 1965). The surface exposures of Palaeocene rocks in Vriddhachalam area are scanty and recorded mainly from the subcrops. The Palaeocene biostratigraphy of the area is, thus, largely based on the subsurface data obtained from shallow dug wells and shallow bore holes.

During three field trips to the area undertaken between 1977 and 79, two of us (KPJ & RG) encountered a few Cretaceous-Tertiary

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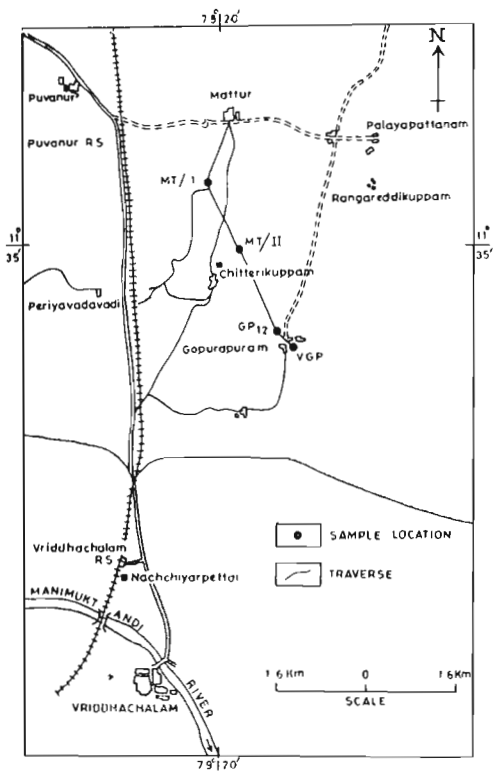
sequences in shallow irrigation dug wells between Mattur and Gopurapuram, north-east of Vriddhachalam (Text-fig. 1). Dinoflagellate cysts from these sequences have recently been published by Jain (1978) and Jain and Garg (1979). In the present paper calcareous nannofossils are recorded.

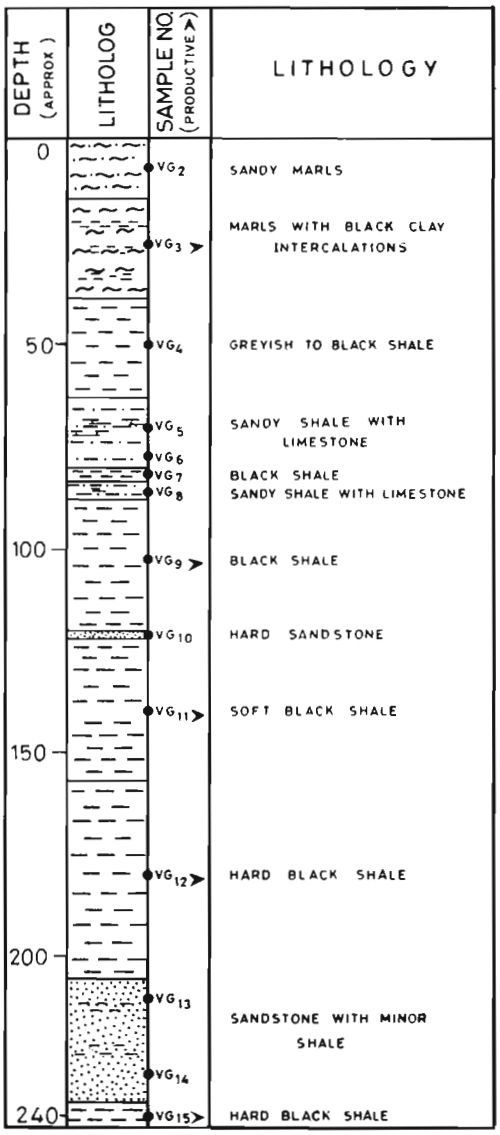
## MATERIAL

The material for the present study is from a bore hole no. VGP (Text-fig. 1) sunk a few meters east of the Gopurapuram-Pallakolai road in the Gopurapuram Village, where a thick sedimentary sequence has been encountered. The drilling has penetrated through nearly 240 m strata. The succession consists dominantly of sandy marl and greyish to black shale with minor sandstone and limestone (Text-fig. 2).

The black shales have yielded a rich dinocyst assemblage at various levels in the sequence but calcareous nannofossils are recovered only from the basal sample




TEXT-FIG. 1 — Map of Vriddhachalam area showing location of samples.




TEXT-FIG. 2 — Lithological sequence of the Gopurapuram borehole (VGP).

VG 15 (Text-fig. 2). The dinoflagellate cysts, characterized by the presence of *Wetzeliella* (*Apectodinium*) *homomorpha* plexus, occur throughout the sequence. The dinocyst assemblage will be dealt in detail elsewhere.

All the figured slides are housed at the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow.

## CALCAREOUS NANNOFOSSIL ASSEMBLAGE

The calcareous nannofossil assemblage is quite rich though the individual specimens are fewer in number. The dominant and important coccolith and discoaster taxa present in the assemblage are listed below. The assemblage as a whole is characterized by the predominance of *Braarudosphaera* and *Micrantholithus* species.

## SYSTEMATIC DESCRIPTION

Family — Zygodiscaceae Hay & Mohler, 1967

**Genus — *Zygolithus* Matthews, 1956**

*Zygolithus concinnus* Martini, 1961

Pl. 1, figs 5, 6

Family — Coccolithaceae Kamptner, 1928

**Genus — *Markalius* Bramlette & Martini, 1964**

*Markalius inversus* (Deflandre) Bramlette & Martini, 1964

Pl. 1, fig. 9

**Genus — *Coccolithus* Schwarz, 1894**

*Coccolithus pelagicus* (Wallich) Schiller, 1930

Pl. 1, figs 12, 13

**Genus — *Chiasmolithus* Hay & Mohler, 1967**

*Chiasmolithus consuetus* (Bramlette & Suilivan) Hay & Mohler, 1967

Pl. 1, figs 10, 11

*Chiasmolithus solitus* (Bramlette & Sullivan) Hay & Mohler, 1967

Pl. 1, fig. 3

*Chiasmolithus* sp. 1

Pl. 1, fig. 4

*Remarks* — These forms exhibit much smaller central area (5 μm along major axis) and sharply curved ends of the bars, thus could not be compared with the known species of the genus *Chiasmolithus*.

**Genus — *Cyclolithella* Loeblich & Tappan, 1963**

*Cyclolithella ?robusta* (Bramlette & Sullivan) Radomski, 1968

Pl. 1, figs 7, 8

Family — Thoracosphaeraceae Deflandre, 1952

**Genus — *Thoracosphaera* Kamptner, 1927**

*Thoracosphaera operculata* Bramlette & Martini, 1964

Pl. 1, figs 1, 2

Family — Braarudosphaeraceae Deflandre, 1947

**Genus — *Braarudosphaera* Deflandre, 1947**

*Braarudosphaera bigelowii* (Gran & Braarud) Deflandre, 1947

Pl. 1, figs 31, 32

*Braarudosphaera discula* Bramlette & Riedel, 1954

Pl. 1, figs 29, 30

*Braarudosphaera africana* Stradner, 1961

Pl. 1, fig. 27

*Braarudosphaera* sp. 1

Pl. 1, fig. 28

*Remarks* — But for its much smaller size, this tiny form about 6-7 μm in diameter, closely resembles *B. discula*.

**Genus — *Micrantholithus* Deflandre, 1950**

*Micrantholithus flos* Deflandre, 1950

Pl. 1, fig. 33

*Micrantholithus vesper* Deflandre, 1950

Pl. 1, figs 18-21

*Micrantholithus attenuatus* Bramlette & Sullivan, 1961

Pl. 1, figs 34, 35

*Micrantholithus pinguis* Bramlette & Sullivan, 1961

Pl. 1, figs 22, 23

*Micrantholithus* sp. 1

Pl. 1, fig. 17

*Remarks* — This form is comparable with *Micrantholithus vesper* but differs in its much smaller size (6-8 μm) and acutely pointed rays.

*Micrantholithus* sp. 2

Pl. 1, fig. 24

*Remarks* — These forms appear closest to *Micrantholithus pinguis* but are distinguished due to their small size (5-7 μm) and broadly rounded tips of the rays.

*Micrantholithus* sp. 3

Pl. 1, fig. 25

*Remarks* — This form compares best with *Micrantholithus flos* but for its smaller size and deeply incised margins of the pentaliths.

*Micrantholithus* sp. 4

Pl. 1, fig. 26

*Remarks* — These forms are almost identical with *Micrantholithus flos* but for their much smaller size (7-8 μm).

Family — Discoasteraceae Vekshina, 1959

**Genus — *Discoaster* Tan, 1927**

*Discoaster helianthus* Bramlette & Sullivan, 1961

Pl. 1, fig. 15

*Discoaster mediosus* Bramlette & Sullivan, 1961

Pl. 1, fig. 16

*Discoaster multiradiatus* Bramlette & Riedel, 1954

Pl. 1, fig. 14

*Discussion* — The nannofossil assemblage contains several long ranging species like *Coccolithus pelagicus*, *Markalius inversus*, *Micrantholithus pinguis*, *Braarudosphaera bigelowii* and *B. discula*. However, the presence of *Discoaster multiradiatus* is very significant. This species appears for the first time in the NP9 Zone of Martini (1971) and CP8 Zone of Okada and Bukry (1980), indicating uppermost Palaeocene age for the sediments. The NP9 zone of Martini is defined as the interval from the first occurrence of *D. multiradiatus* to the first occurrence of *Marthasterites bramlettei*.

The age derivations based on nannoplankton are in conformity with the distribution of planktonic foraminifera recorded by Mehrotra and Banerji (1972) from another borehole (210 m deep) drilled in the Gopurapuram Village. They recorded the occurrence of *Globorotalia velascoensis* up to the depth of ca. 190 m only, the underlying ca. 20 m claystone unit did not yield any foraminifera. The drilled sequence has been dated by them as Upper Sparnacian (uppermost Palaeocene), equivalent to the Standard Planktonic Foraminiferal Zone, *Globorotalia velascoensis* Zone (Zone P5; Berggren, 1969). Martini (1971) has also shown his NP9 Zone to be equivalent to Zone P5, the *Globorotalia velascoensis* Zone. The present find of nannofossils, therefore, suggests that the uppermost Palaeocene (Sparnacian) sediments in Gopurapuram extend further down to a depth of ca. 240 m.

The Upper Palaeocene rocks have also been recently encountered in another shallow well No. GP12 about 2.5 km further SSE of Mattur and north-west of Gopurapuram Village (Text-fig. 1). The well was dug about 200 m westward of milestone 14 on the Gopurapuram-Pallakolai Road. The sequence, in the 6 m deep dug well, comprises 5 m thick sandy marls interbedded with 0.5-0.6 m thick, 2-3 bands of bluish grey calcareous sandstone. This sandstone does not form a persistent bed but occurs as large, oval to round concretions at different levels within the sandy marls. Both sandy marls and calcareous sandstone concretions are fossiliferous.

Calcareous sandstone in thin section is made up of poorly sorted, angular to occasionally subangular quartz held in a micritic (lime mud) matrix. Quartz constitutes more than 90% of the terrigenous material.

The overall aspect of the rock in thin section suggests that the concretions are *in situ*, formed during diagenesis subsequent to the deposition of the sandy marls.

Presence of rare larger foraminifera (*Nummulites* and *Discocylina* species), planktonic foraminifera and several smaller benthonic foraminifera (Rotaliids, Miliolids, etc.) and frequent algae (including *Distichoplax biserialis*) have also been noticed in thin sections. The conventional acid/alkali treatment of this sandstone has further revealed a rich dinoflagellate flora containing *Wetzeliella* (*Apectodinium*) *homomorpha* plexus (sensu stricto, Harland, 1979). The sandy marls have not yielded any palynoflora. Jain and Garg (1979, p. 20) mentioned the presence of *Wetzeliella homomorpha quinquelata* from this material but the subsequent detailed study showed the presence of *Wetzeliella homomorpha* plexus. The biostratigraphic significance of *Wetzeliella* (*Apectodinium*) *homomorpha* plexus has recently been discussed by Harland (1979). It marks the Palaeocene/Eocene boundary or top of Sparnacian. Dutta and Jain (1980) also reported the presence of *Wetzeliella homomorpha* plexus at the contact of Lakadong Sandstone and Umlatdoh Limestone members of the Sylhet Formation, Meghalaya, suggesting Palaeocene/Eocene boundary at this contact.

The Palaeocene sequence recorded by Rajagopalan (1967) from a dug well near Gopurapuram, may possibly be equivalent to the above sequence (Well GP12). In a 5 m thick sequence of marlstone, Rajagopalan (1967, p. 94, figs 1-3) mentioned the presence of two thin beds of hard limestone containing *Discocyclina* species and *Distichoplax biserialis* and compared them with the fossiliferous limestone of the Pondicherry area. The limestone beds of Rajagopalan appear to be the extension of the same calcareous sandstone concretions recorded by Jain and Garg (1979). From marlstones, Rajagopalan (1967) recorded a rich microfauna consisting of foraminifera (including *G. velascoensis*) and ostracoda indicating a Middle-Late Palaeocene age, and further correlated this sequence with the Upper Marlstone Unit of the Pondicherry Formation, from which he (1965) recorded nannoplankton, *Heliolithus riedelii*. This coccolith species is now considered to be the zone marker (NP7 extending up to NP9).

The significance of *Globorotalia velascoensis*, *Discoaster multiradiatus*, *Wetzeliella* (*Apectodinium*) *homomorpha* plexus and to some extent *Distichoplax biserialis* at the top of Palaeocene or Palaeocene/Eocene boundary is thus recognized. Therefore, from the above discussion it is clear that a multidisciplinary approach in marine biostratigraphy would be of much help.

The dominance of tiny braarudosphaerids in the sample is significant favouring low salinity and near shore environment of deposition (Bukry, 1974; Bramlette & Martini, 1964; Martini, 1965).

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## EXPLANATION OF PLATE

(*All magnified.* × 2000; *the coordinates refer to the Amplival Jena Microscope*)

1, 2. *Thoracosphaera operculata* Bramlette & Martini; slide no. 6576; Coordinates: 120·0 × 11·4.

3. *Chiasmolithus solitus* (Bramlette & Sullivan) Hay & Mohler; slide no. 6579; Coordinates: 11·0 × 15·0.

4. *Chiasmolithus* sp. 1; slide no. 6577; Coordinates: 120·5 × 15·0.

5, 6. *Zygolithus concinnus* Martini; slide no. 6576; Coordinates: 11·4 × 14·1.

7, 8. *Cyclolithella ?robusta* (Bramlette & Sullivan); Radomski; slide no. 6577; Coordinates 81·2 × 13·8.

9. *Markalius inversus* (Deflandre) Bramlette & Martini; slide no. 6579; Coordinates: 111·1 × 15·0.

10, 11. *Chiasmolithus consuetus* (Bramlette & Sullivan) Hay & Mohler; slide no 6576; Coordinates: 127·4 × 13·5.

12, 13. *Coccolithus pelagicus* (Wallich) Schiller; slide no. 6576; Coordinates: 127·4 × 13·5.

14. *Discoaster multiradiatus* Bramlette & Riedel; slide no. 6578; Coordinates: 124·2 × 7·6.

15. *D. helianthus* Bramlette & Sullivan; slide no. 6579; Coordinates: 118·0 × 14·1.

16. *D. mediosus* Bramlette & Sullivan; slide no. 6579; Coordinates: 115·5 × 15·2.

17. *Micrantholithus* sp. 1; slide no. 6578; Coordinates: 126·7 × 16·1.

18-21. *Micrantholithus vesper* Deflandre; slide no. 6577; Coordinates: 119·6 × 11·3 & 119·6 × 11·3 respectively.

22, 23. *Micrantholithus pinguis* Bramlette & Sullivan; slide no 6576; Coordinates: 113·0 × 12·3.

24. *Micrantholithus* sp. 2; slide no. 6579; Coordinates; 79·5 × 21·6.

25. *Micrantholithus* sp. 3; slide no. 6580; Coordinates: 116·5 × 13·0.

26. *Micrantholithus* sp. 4; slide no. 6582; Coordinates: 124·8 × 17·5.

27. *Braarudosphaera africana* Stradner; slide no. 6576; Coordinates: 121·9 × 16·6.

28. *Braarudosphaera* sp. 1; slide no. 6581; Coordinates: 119·0 × 13·3.

29, 30. *B. discula* Bramlette & Riedel; slide nos. 6576 & 6579; Coordinates: 126·5 × 14·3 & 116·9 × 13·8 respectively.

31, 32. *B. bigelowi* (Graan & Braarud) Deflandre; slide no. 6577; Coordinates: 118·0 × 15·3 & 119·8 × 11·2 respectively.

33. *Micrantholithus flos* Deflandre; slide no. 6579; Coordinates: 114·6 × 14·8.

34, 35. *M. attenuatus* Bramlette & Sullivan; slide nos. 6576 & 6582; Coordinates: 122·1 × 15·6 & 84·0 × 40·0 respectively.

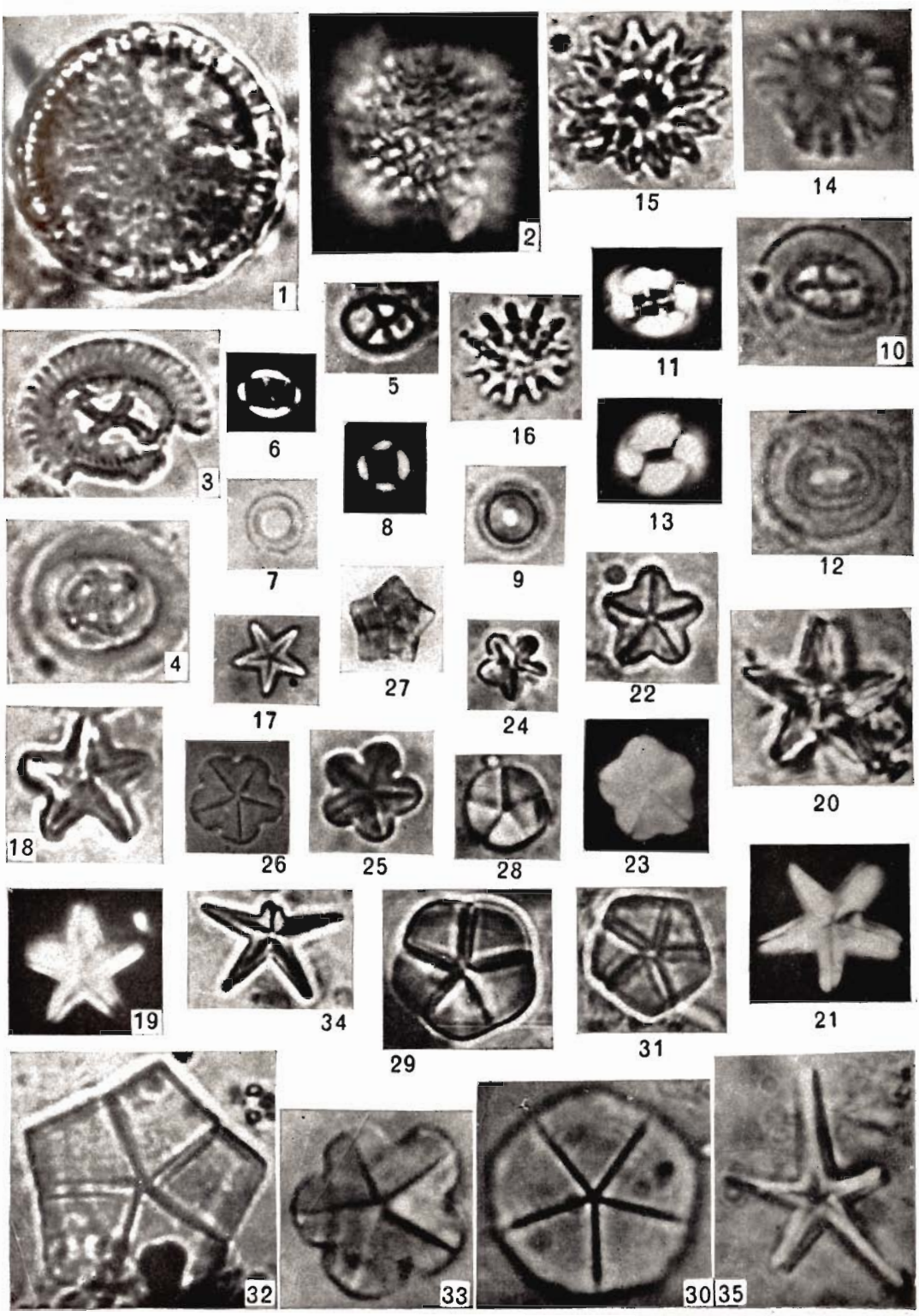
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PLATE 1