MICROBIOTA FROM THE SUKET SHALES, RAMAPURA, VINDHYAN SYSTEM (LATE PRE-CAMBRIAN), MADHYA PRADESH

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ABSTRACT

A comprehensive account of microbiota comprising of algae, fungi and acritarchs are described from the Suket Shales of Ramapura, Madhya Pradesh (Semri Series, Vindhyan System) along with a critical study on the disc-shape impressions or compressions earlier described under *Fermoria* Chapman. The study shows that these disc-shape forms, *Fermoria* are either remains of colonial algae or acritarchs (*Tasmanites*, *Nucellosphaeridium* etc.). A comparison of Suket Shale microbiota with the known Pre-cambrian microbiota shows that a Late Pre-cambrian age can be assigned to these beds.

INTRODUCTION

FERMORIA Chapman, the circular or oval disc-like remains are known long back from the Suket Shales (Semri Series, Vindhyan) of Ramapura, Madhya Pradesh. The affinities of these remains are still controversial. In addition to this preliminary account on the microbiota comprising of algae, fungi and acritarch remains from these rocks have earlier been published by Sitholey, Srivastava and Varma (1953), Maithy (1968) and Shrivastava (1972). The present paper deals with a systematic description of microbiota recovered from the Suket Shales along with a critical study on the disc-like forms *Fermoria*.

GEOLOGY

The area under investigation forms the part of the Chitor-Jhalarpatan Vindhyan tract (Map 1) where only the lower part of Vindhyan succession is exposed. It constitutes the lower part of Kaimur Series and Upper Semri Series, as shown below (after Heron, 1936, p. 70; Shrivastava, 1972, p. 3).

Kaimur Sandstone
Suket Shales
Nimbahera Limestone
and Shales
Khori-Malan Shandstone

The Suket Shales form the topmost beds of Semri Series. The rocks are well exposed in the Chambal River as well as tributary nala sections. The Suket Shales are thinly bedded, fine grained, drab to buff coloured in upper horizons but change to purple, chocolate or greenish grey colours in the lower horizons and break easily into small cakes. The basal beds of this member are hard micaceous and flagy and are associated with rare calcareous beds and thin layers of impure limestone. These shales are low dipping to almost horizontal and lie conformably over the Nimbahera Limestone. The material for the present study was collected from the culvert of Talsoi River, about 1 km from Ramapura Dak Bungalow. The shales are light greenish-grey in colour and fine grained. On their surface carbonised impressions of disc-like remains are preserved. The disc-like remains have been studied under incident light and later they were isolated from the rocks by transfer method. Microfossils were recovered from the rocks by treatment wth hydrofluoric acid.

MICROBIOTA

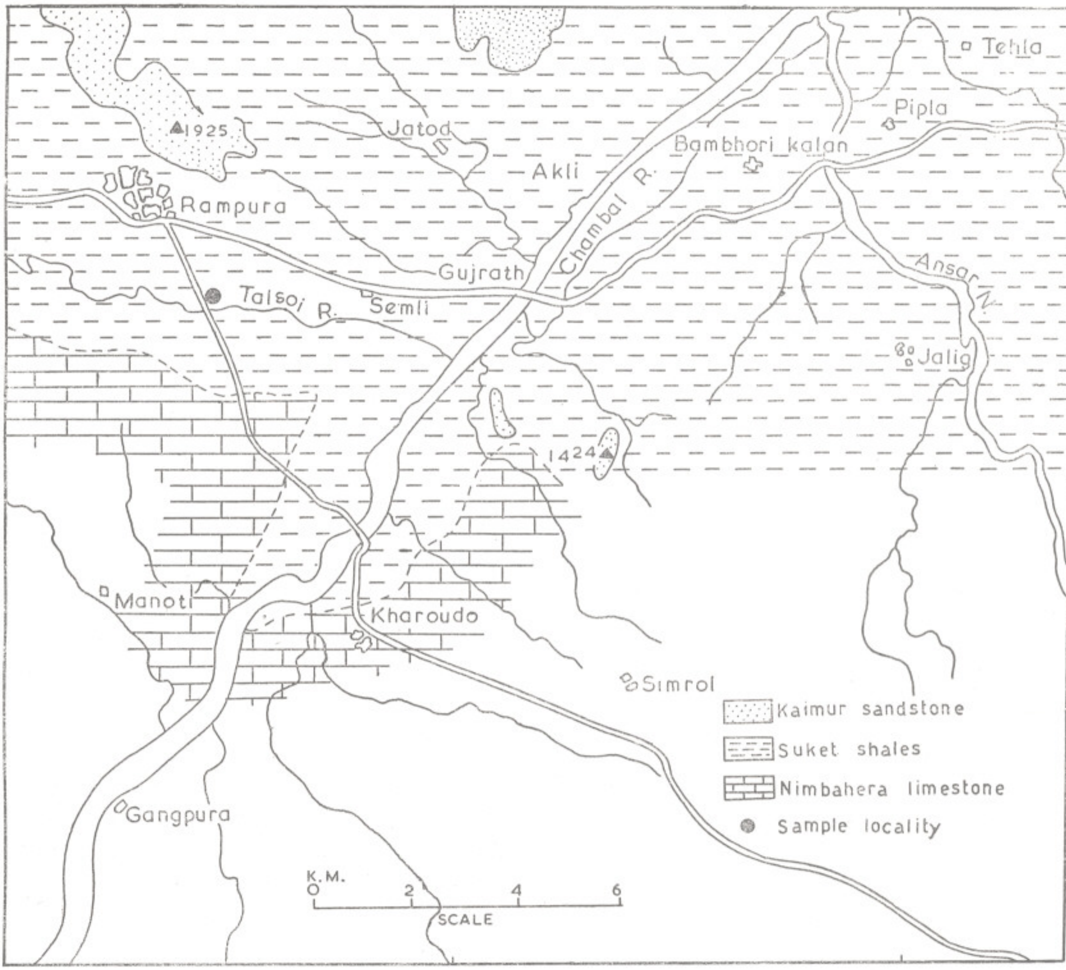
The preservation of material is enough good for identification. In cases the structure of acritarchs have been distorted due to ill preservation. This may confuse the identification of some forms. Therefore, for the present study, well preserved forms have been taken into consideration. The elements of microbiota are mostly dark brown or golden brown in colour.

Repository — All the figured slides are preserved at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC DESCRIPTION

ALGAE

Phylum — CYANOPHYTA
Class — CYANOPHYCEAE
Order — CHROOCOCCALES
Family — CHROOCOCCACEAE



Map 1. Showing the Vindhyan rock succession around Ramapura and sampling locality.

***Myxococcoides* Schopf, 1968**

Myxococcoides ramapuraensis sp. nov.

Pl. 1, fig. 1

Diagnosis — Cells commonly spherical to subspherical, clumped in a more or less ellipsoidal colony composed of few to twenty cells; surface texture nearly psilate to finely punctate; cell diameters vary between 20-30 µm; cell walls robust and thick, cells embedded in a somewhat granular non-lamellated organic matrix up to 4 µm thick at the periphery of colony. Colonies vary in number of component cells, the cells being geometrically unordered in relation to colony shape.

Holotype — Slide no. 4929; Pl. 1, fig. 1.

Locality — As noted above.

Comparison — In *Myxococcoides minor* Schopf (1968), *M. reticulata* Schopf (1968), *M. inornata* Schopf (1968), *M. indicus* Venkatachala *et al.* (1974) and *M. elongatus* Venkatachala *et al.* (1974) the cells of the colonies are comparatively smaller in size. Moreover, the organic matrix is also not well developed as in the Ramapura forms.

Myxococcoides globosa sp. nov.

Pl. 1, fig. 2

Diagnosis — Cells commonly circular, clumped in a more or less globular colony, composed of few to thirty cells; surface texture nearly psilate, cell diameter between

20-30 μm; cell wall moderately thick; cells embedded in a somewhat granular non-lamellated organic matrix up to 2 μm. The cells being geometrically ordered in relation to colony and shape.

Holotype — Slide no. 4929; Pl. 1, fig. 2.

Locality — As noted above.

Comparison — The colony is comparable to *Myxococcoides minor* Schopf (1968) in its overall shape, but differs in surface texture.

Myxococcoides magnus sp. nov.

Pl. 1, fig. 3

Diagnosis — Cells commonly circular, or circular-oval-circular, thin, lumped in form of a colony composed of 20 to 40 cells; surface texture smooth, cell diameter between 50-130 μm; cells clumped together in a somewhat granular non-lamellated organic matrix.

Holotype — Slide no. 4930; Pl. 1, fig. 3.

Locality — As noted above.

Comparison — *Myxococcoides magnus* sp. nov. differs from all the known species by its large size cells.

***Palaeoanacystis* Schopf, 1968**

Palaeoanacystis suketensis sp. nov.

Pl. 1, fig. 4

Diagnosis — Cells circular to ellipsoidal, occasionally polyhedral and angular due to mutual compression; commonly clumped together in more or less globular colonies, composed of many to more than 100 cells; surface texture psilate, unornamented; cell diameter vary from 8-12 μm; cells not encompassed by individual sheath. A common organic matrix is evidenced by well developed colonial habit.

Holotype — Slide no. 4931; Pl. 1, fig. 4.

Locality — As noted above.

Comparison — *Palaeoanacystis vulgaris* Schopf (1968) compares in its exine structure, but the shape of colonies are different and the colonies are composed of much higher number of cells. *Palaeoanacystis psilata* Maithy (1975) differs from *P. suketensis* sp. nov. in the size of cells. Moreover, in *P. psilata* the number of cells in the colony are few.

Palaeoanacystis punctatus sp. nov.

Pl. 1, fig. 5

Diagnosis — Cells circular to oval in outline; commonly clumped together in more or less circular to oval colonies, composed of many to more than 100 cells; surface texture punctate, cell dimension 6-20 μm; cells not encompassed by individual sheath, common organic matrix is evidenced by well developed colonial habit.

Holotype — Slide no. 4931; Pl. 1, fig. 5

Locality — As noted above.

Comparison — *Palaeoanacystis vulgaris* Schopf (1968), *P. psilata* Maithy (1975) and *P. suketensis* sp. nov. differs by the psilate ornamentation.

Palaeoanacystis verucosus sp. nov.

Pl. 1, fig. 6

Diagnosis — Cells circular to ellipsoidal, occasionally polyhedral and angular due to mutual compression, commonly clumped together in more or less globular colonies composed of 40 to 100 cells; surface texture microverrucose, cell diameter varies from 12-20 μm; cells mediumly thick, not encompassed by individual sheath, common organic matrix is evidenced by well developed colonial habit.

Holotype — Slide no. 4931; Pl. 1, fig. 6

Locality — As noted above.

Comparison — *Palaeoanacystis vulgaris* Schopf (1968), *P. psilata* Maithy (1975) and *P. suketensis* sp. nov. differ from *P. verrucosus* by psilate exine. *P. punctatus* sp. nov. is characterised by punctate exine.

Palaeoanacystis reticulatus sp. nov.

Pl. 1, fig. 7

Diagnosis — Cells circular to oval, thick, clumped together in more or less circular to oval colonies, composed of few to 40 cells; surface texture reticulate, muri raised; cell diameter 20-25 μm; cells not encompassed by individual sheath, common organic matrix is evidenced by well developed colonial habit.

Holotype — Slide no. 4932; Pl. 1, fig. 7

Locality — As noted above.

Comparison — The present species differs from all the known species of *Palaeoanacystis* in the exine ornamentation of cells.

***Aphanocapsaopsis* gen. nov.**

Genotype — *Aphanocapsaopsis sitholeyii* sp. nov.

Generic Diagnosis — Cells spherical to ellipsoidal, many loosely arranged without any order; cells clumped together in flat colonies; surface texture smooth to punctate; cells not encompassed by individual sheaths; a common organic matrix is evidenced by well developed colonial habit; new colonies probably produced by fragmentation of pre-existent colonies.

Etymology — With reference to morphological similarity to the modern algae of the genus *Aphanocapsa* Nag.

Comparison — *Aphanocapsaopsis* gen. nov. is distinct from *Palaeoanacystis* Schopf (1968) and *Myxococcoides* Schopf (1968). In both genera, the cells form either a spherical or globular colonies, whereas in *Aphanocapsaopsis* the cells form flat colonies. *Glenobotrydion* Schopf (1968), though shows a colony with loosely arranged cells, but distinct pyrinoid like structure is present in each cells.

Aphanocapsaopsis sitholeyii sp. nov.

Pl. 1, figs. 8, 9

Synonymy:

1953? Cyanophycae Sitholey, Verma & Srivastava, p. 198, pl. 3, figs. 1-4.

Diagnosis — Cells spherical, 20-30 µm; loosely arranged, 20-30 in number, surface texture smooth, occasionally irregular folds are present; cells not encompassed by individual sheath.

Holotype — Slide no. 4929; Pl. 1, fig. 8.

Locality — As noted above.

Discussion — The spheroidal microfossils here included in the genus *Aphanocapsaopsis* are referred to Chroococcaceae on the basis of their size and shape, procaryotic appearance and colonial habit. Among living coccoid blue-green algae, these colonies seem most similar to the modern Chroococcacean algae of the genus *Aphanocapsa* Nag.

Derivation of Name — This species is named after Dr. R. V. Sitholey for his contribution to the microbiota of Suket Shales.

Aphanocapsaopsis ramapuraensis sp. nov.

Pl. 1, figs. 10, 11

Diagnosis — Cells spherical, 10-20 µm; many (30-60 cells) loosely arranged without any order, cells clumped together in flat colonies; surface texture punctate and folds absent.

Holotype — Slide no. 4929; Pl. 1, fig. 10

Locality — As noted above

Comparison — Cells of *Aphanocapsaopsis sitholeyii* sp. nov. are bigger in size. Moreover, in *A. ramapuraensis* the colonies are composed of much higher number of cells than *A. sitholeyii*. In addition to this the exine in *A. sitholeyii* is smooth.

Order — NOSTOCALES

Family — OSCILLATORIACEAE

Oscillatoriopsis Schopf, 1968

Oscillatoriopsis psilata sp. nov.

Pl. 2, fig. 12

Diagnosis — Trichomes multicellular, uniseriate, unbranched, not constricted at septa; cross walls distinct, smooth; somewhat granular; trichomes solitary, slightly curved or bent, more or less straight up to 140 µm long, cells of trichomes cylindrical, broader than longer, 4 µm long and 6-8 µm broad, terminal and basal cells not known.

Holotype — Slide no. 4929; Pl. 2, fig. 12.

Locality — As noted above.

Comparison — *Oscillatoriopsis obtusa* Schopf (1968) recorded from the Bitter Springs Formation (Late Pre-cambrian) from the Rose River area of Central Australia differs in having cells equally longer than broad. *O. breviconvexa* Schopf & Blacic (1971) recorded from the Bitter Springs Formation (Late Pre-cambrian) of the north-central Amadeus Basin (Australia), has constricted cross walls. Similar remains have also been observed by Timofeev (1966, pl. 2, figs. 4-6) from the Late Pre-cambrian of Russian platform.

***Palaeoscytonema* gen. nov.**

Genotype — *Palaeoscytonema srivastavae* sp. nov.

Generic Diagnosis — Filaments distinct, errect, incomplete, measuring 200-240 µm in length, branching absent, sheath thick, 2 times broad in size than length, trichomes 6-8 µm broad and 2-4 µm long, heterocysts not known.

Etymology — With reference to the genus *Scytonema* Ag.

Palaeoscytonema srivastavae sp. nov.

Pl. 2, figs. 13, 14

Diagnosis — As for the genus.
Holotype — Slide no. 4939; Pl. 2, fig. 13.
Locality — As mentioned above.
Discussion — In general morphology the filaments are comparable to the cyanophycean genus *Scytonema* in the presence of thick sheath. On the basis of nature of sheath it is comparable to *Scytonema millei* (see Desikachary, 1959, p. 486, fig. 6).
Derivation of Name — This species is named after Late P. N. Srivastava for his contribution to the microbiota of Suket Shales.

FUNGI

Phylum — EUMYCOPHYTA (?)

Genus — *Eomycetopsis* Schopf, 1968

Eomycetopsis psilata sp. nov.

Pl. 2, fig. 15

Diagnosis — Filaments commonly solitary, non-septate, rarely in groups of few entangled filaments; surface of filament smooth, occasionally rounded scars present, filaments up to 200 μm long, regularly, cylindrical, 3-4 μm in diameter.
Holotype—Slide no. 4931; Pl. 2, figs. 15, 26.
Locality — As noted above.
Comparison — *Eomycetopsis robusta* Schopf (1968) and *E. filiformis* Schopf (1968) differ from *E. psilata* sp. nov. by granular surface texture. *E. cylindrica* Maithy (1975) has smooth exine, however, the forms are characterised by having the filaments interlaced together in close cylindrical mass.

Eomycetopsis pflugii sp. nov.

Pl. 2, fig. 16

Diagnosis — Filaments solitary, rarely interlaced in a loosely woven parenchyma like mass, surface intrapunctate. Lateral walls 1 μm thick. Filaments up to 160 μm long (incomplete filament), cylindrical with variance of diameter less than 1 μm. Reproductive structures unknown.
Holotype — Slide no. 4933; Pl. 2, fig. 16.
Locality — As noted above.
Comparison — *Eomycetopsis pflugii* differs from all the known species of *Eomycetopsis* in the exine structure of the filament.
Derivation of Name — This species has been named after Prof. H. D. Pflug for his contribution to Pre-cambrian microbiota.

Eomycetopsis reticulata sp. nov.

Pl. 2, fig. 17

Diagnosis — Filaments commonly solitary, occasionally in group, rarely showing plectenchymatous organisation; filament thick, dark brown, exine intrareticulate; muri raised and lumina ± equal size, filament 60-80 μm long.
Holotype — Slide no. 4939; Pl. 2, fig. 17.
Locality — As noted above.
Comparison — *Eomycetopsis reticulata* sp. nov. is distinguishable from the known species by its reticulate exine.

ACRITARCHS

Group — ACRITARCHA Evitt, 1963
Sub-Group — SPHAEROMORPHITAE Downie, Evitt & Sarjeant, 1963

***Protosphaeridium* Timofeev, 1963**

Protosphaeridium volkovae sp. nov.

Pl. 2, fig. 18

Diagnosis — Vesicles circular to circular-oval in outline, 20-40 μm, exine smooth to intrapunctate, wall thin with some folds on the margin.
Holotype — Slide no. 4932; Pl. 2, fig. 18.
Locality — As noted above.
Comparison — *Protoleiosphaeridium cambriense* Timofeev (1959) differs in having a large diameter and a structured exine. *P. diatretus* Salujha, Rehman & Rawat (1971) is smaller in size with distinct perforations. *P. problematicum* Venkatachala, Bhandari, Chaube & Rawat (1974) differs due to its irregular shape. *P. kaladgiensis* Venkatachala & Rawat (1973) from Kaladgi Basin is characterised by its pitted appearance. *P. densum* Maithy (1975) and *P. laevigatum* Maithy (1975) from the Bushimay system of (Late Pre-cambrian) of Kanshi, Zaire differs from the present form in having smooth exine.
Derivation of Name — This species is named after Dr. N. A. Volkova for her contribution to Pre-cambrian and Cambrian acritarchs.

Protosphaeridium densum Maithy, 1975

Pl. 2, fig. 19

Description — Oval, 30-40 μm, dark brown, laevigate, folds absent.

Comparison — The specimen compares to *Protoleiosphaeridium densum* Maithy (1975) from the Late Pre-cambrian of Zaire.

Granomarginata Naumova, 1961

Granomarginata rotata sp. nov.

Pl. 3, fig. 23

Diagnosis — Vesicle circular, 130-190 μm, exine thin, arranged with closely spaced grana, which are arranged all over regularly, folds present.

Holotype — Slide no. 4929; Pl. 3, fig. 23.

Locality — As noted above.

Comparison — *Granomarginata prima* Naumova (1960), *G. primitiva* Salujha, Rehman & Arora (1971) and *G. minuta* Maithy (1975) differ from *G. rotata* due to their small size.

Symplassosphaeridium Timofeev, 1959

Symplassosphaeridium bulbosum sp. nov.

Pl. 2, fig. 20

Diagnosis — Vesicle 50-70 μm, spherical, dark brown, body exine well divided into several bulb-like projecting structures, bulbs ±4 μm in diameter.

Holotype — Slide no. 4932; Pl. 2, fig. 20.

Locality — As noted above.

Comparison — *Symplassosphaeridium incrustatum* Timofeev (1959, pl. 1, fig. 10) compares in organisation, however, the projections in *S. bulbosum* are conspicuous.

Orygmatosphaeridium Timofeev, 1959

Orygmatosphaeridium plicatum sp. nov.

Pl. 3, fig. 26

Diagnosis — Vesicle spherical with irregular folds on margin, 60-180 μm, exine thin, surface pitted, pits small and closely arranged.

Holotype — Slide no. 4933; Pl. 3. fig. 26.

Locality — As noted above.

Comparison — *Orygmatosphaeridium ruminatum* Timofeev (1959) is much bigger in size and the pits are also bigger, In *O. vulgare* Maithy (1975) the pit margins are raised.

Vavosphaeridium Timofeev, 1956

Vavosphaeridium vindhyanensis n. comb.

Pl. 4, fig. 27

Synonymy:

1959 — *Retisphaeridium vindhyanensis* Maithy, p. 49; pl. 1, figs. 4-5.

Diagnosis — Dark brown, spherical, 90-150 μm, exine thick, micro-reticulate, reticulum distinct and complete, muri thick, ±2 μm, lumina 4-8 μm, polygonal in outline.

Holotype — Slide no. 2803, Pl. 1, fig. 4, 1969.

Comparison & Remarks — *Vavosphaeridium michailovskyi* Timofeev (1959) has incomplete reticulum. *V. bharadwajii* Salujha, Rehman & Rawat (1971) is comparatively small in size. *V. densum* Maithy (1975) has small size lumina. Maithy (1969) described these grains under *Retisphaeridium* Staplin *et al.* (1975). A re-examination of the vesicles show that they do not fall under the generic circumscription of *Retisphaeridium*, hence, they are transferred to *Vavosphaeridium* to which they agree morphologically.

Archaeofavosina Naumova, 1960

Archaeofavosina reticulata sp. nov.

Pl. 3, figs. 24, 25

Diagnosis — Vesicle 80-150 μm, circular, brown, exine thick with broad reticulum, muri raised and thick, 6-8 μm broad, areas of lumina polygonal, 20-40 μm wide, in between reticulum irregular-shaped pitted structure present, pits closely arranged.

Holotype — Slide no. 4934; Pl. 3, fig. 24.

Locality — As noted above.

Comparison — *Archaeofavosina sinuta* Maithy (1975) compares to the present vesicle, but differs due to thin exine.

Sub-Group — MEGASPHAEROMORPHITAE Timofeev, 1970

Kildinella Timofeev, 1963

Kildinella suketensis sp. nov.

Pl. 3, fig. 21

Diagnosis — Light brown, circular to subcircular, 110-180 μm, exine thin, smooth, intrapunctate structure, several irregular folds present.

Holotype — Slide no. 4934; Pl. 3, fig. 21

Locality — As noted above.

Comparison — *Kildinella magna* Timofeev (1970) morphologically agree to *K. suketensis* sp. nov. but is much larger in size. *K. timofeevii* Maithy (1975) from the Bushimay Formation of Kanshi, Zaire are spherical to subspherical in outline. Moreover, they are smaller in size.

Kildinella minuta sp. nov.

Pl. 3, fig. 22

Diagnosis — Dark brown, oval, 50-90 μm, exine smooth, intrapunctate structure with few irregular folds.

Holotype — Slide no. 4934; Pl. 3, fig. 22.

Locality — As noted above.

Comparison — *Kildinella minuta* sp. nov. differs from all the known species of *Kildinella* by its characteristic small size.

Nucellosphaeridium Timofeev, 1969

Nucellosphaeridium minimum sp. nov.

Pl. 4, figs. 30, 31

Diagnosis — Vesicle circular, 60-80 μm, inner body 16-22 μm, circular, thick, dark brown, laevigate; outer area with microreticulate exine.

Holotype — Slide no. 4934; Pl. 4. fig. 30.

Locality — As noted above.

Comparison — *Nucellosphaeridium minimum* sp. nov. compares to *N. bellum* Timofeev, 1970, but *N. minimum* is comparatively much smaller in size.

Nucellosphaeridium zonatum sp. nov.

Pl. 4, fig. 29

Diagnosis — Vesicle circular, 250-300 μm; inner body circular, dark brown, punctate, 140-180 μm; outer area 20-40 μm broad with microreticulate exine, muri and lumina ± equal size; on the margin a distinct thick zone present, ± 16 μm broad.

Holotype — Slide no. 4939; Pl. 4, fig. 29.

Locality — As noted above.

Comparison — The present species differs from all the known species by its bigger size and the presence of marginal thick zone.

Family — TASMANEACEAE Sommer, 1965

Zonosphaeridium Timofeev, 1956

Zonosphaeridium punctatum sp. nov.

Pl. 4, fig. 28

Diagnosis — Circular, 50-70 μm, inner zone circular, 40-50 μm, comparatively thicker than outer zone, laevigate; outer zone 10 μm broad, thin with closely arranged puncta.

Holotype — Slide no. 4931; Pl. 2, fig. 20.

Locality — As noted above.

Comparison — *Zonosphaeridium actinomorphum* Timofeev (1959) and *Z. limpatum* Timofeev (1959) differs by its smooth exine. *Z. absolutum* Timofeev (1959) and *Z. densum* Maithy (1975) have reticulate exine, *Z. foveolatum* Maithy (1975) differs by closely arranged foveolae.

Tasmanites (Newt.) Eisenack, 1958

Tasmanites vindhyanensis sp. nov.

Pl. 4, figs. 32, 33

Synonymy:

1968 — *Tasmanites* sp. Maithy, p. 50, pl. 1, figs. 6, 7.

Diagnosis — Vesicles circular, 500-1250 μm, surface covered with numerous puncta or pores with thick border, uniformly distributed over the entire surface; occasionally more concentrated at the central part; irregular folds are present on the margin.

Holotype — Slide no. 2804; Pl. 1, fig. 6, 1968.

Locality — As noted above.

Comparison — *Tasmanites huronensis* (Dawson) Winslow (1962) shows two distinct zones and the puncta are much bigger in size. *T. sinuosus* Winslow (1962) is much smaller in size than *T. vindhyanensis* sp. nov. *Tasmanites punctatus* Newton (1875) has several irregular folds and has reticulation in between puncta. In *T. vindhyanensis* the surface is smooth.

INCERTAE-SEDIS

cf. *Kakabekia* sp.

Pl. 5, fig. 34

Diagnosis — Structure showing tripartite organization consisting of globose bulb, slender stipe and a club-shape mantle with rounded apex, overall length 240 μm, diameter of bulb 60 μm, shows intrareticulate structure.

Comparison — The specimen somewhat shows a tripartite organisation, therefore, it has been refered to cf. *Kakabekia*. *Kakabekia umbellata* Barghoorn & Tyler (1965) differs due to umbrella-like mantle with radiating vein like structure. *K. flabeliformis* Maithy (1975) has cordate bulb. *K. rara* Maithy (1975) differs by funnel-shaped mantle.

DISC-LIKE REMAINS

On the Suket shales of Ramapura there are several impressions of circular or circular-oval discs. These forms have earlier been described under *Fermoria* (Chapman, 1935; Sahni, 1936) and *Krishanania* (Sahni & Srivastava, 1954). The nature of these remains are doubtful, therefore, a detailed study has been undertaken. At first, the morphology of discs were studied under direct light. Later, they were isolated from the rock by transfer method.

The following types of discs are identifiable in impression form:

Type-1

Pl. 5, fig. 37

Black circular discs, diameter 2 mm, body with distinct concentric rings, surface show fine puncta-like structure. In the centre 3 circular bodies are seen. They are arranged in inter-radial area of triradiate mark.

The specimens agree to the figured specimens of *Fermoria* by Chapman (1935, pl. 1, figs. 1-6; pl. 2, fig. 5) and Sahni (1936, pl. 47, figs. 1, 2, 4).

Type-2

Pl. 5, fig. 35

Brown coloured disc, diameter 3 mm, distinct folds present near the margin, surface punctate. The specimen compares with the figured specimens by Chapman (1935, pl. 2, figs. 3, 4) and Sahni (1936, pl. 47, fig. 3).

Type-3

Pl. 5, fig. 36

Oval to circular-oval discs, slightly tapering on one side, outer margin has a ring, a triradiate ridge divides the disc into three distinct zones.

Type-4

Pl. 5, fig. 38

Roundly-oval in shape, 2 mm in diameter with irregular wrinkles on surface, in the centre a small circular body is preserved.

Type-5

Pl. 5, fig. 39

Circular discs, ± 2 mm in diameter with broad reticulum on surface.

Type-6

Pl. 5, fig. 40

Small circular to oval discs, $\pm 0{\cdot}5$ mm in dimension surface shows punctate structure.

These disc-like bodies on isolation from rocks exhibit several distinct morphological entities. They are comparable to the algae, fungi and acritarch remains recovered from maceration of shales. The bigger impression of discs are either acritarchs, viz., *Tasmanites* (Type-1, 2) *Vavosphaeridium* (Type-5) and *Nucellosphaeridium*, (Type-6) or algal colonies, viz., *Myxococcoides* (Type-35) and *Palaeoanacystis*. While the small discs (Type-6) on yield shows remains of small acritarchs. Thus, we find that these remains of discs are quite heterogeneous in nature when their morphological details are known on isolation. Hence, it is proposed here to use the name *Fermoria* for these disc-like remains, when preserved only in the form of impressions.

DISCUSSION

Much controversy remained in past about the nature of *Fermoria*. Brachiopod affinity has been opined by Jones (1909), Matley (see Heron, 1923), Walcott and Resser (see Pascoe, 1927) and Chapman (1935). Sahni (1936) and Sahni and Srivastava (1954) considered them to be algal in nature. Misra (1951) and Misra and Dube (1952) considered them to be inorganic colloidal precipitation. Maithy (1969) opined that *Tasmanites* and *Fermoria* may be allied forms. The present observations indicate that these remains are much more diversified in nature. They represent quite different types referable to algal colonies and acritarchs on isolation from rocks. Therefore, it is proposed to restrict the use of *Fermoria* only for the disc-like impressions.

The microbiota of Suket Shales, Ramapura is characterised by the presence of algae, fungi and acritarchs. Till now very few assemblages of this type are known from the Pre-cambrians (Bushimay Formation, Zaire; Maithy, 1975; Dharwaras, Mysore; Venkatachala *et al.*, 1974 and, Timofeev, 1966). This occurrence may be due to the ecological conditions which must have prevailed at that time. The occurrence of algae and acritarchs together indicates, either the condition for growth of algae was becoming gradually adverse as a result of which algal cyst was formed or it indicates that the condition was going to be gradually favourable for growth of algae from cyst condition. However, no specific evidence is available to say, which of the above conditions were existing during the period of fossilisation.

The microbiota of Suket Shales shows predominance of algae (see Table 1) *Myxococcoides*, *Palaeoanacystis*, and *Aphanocapsiopsis*. The filamentous type, *Oscillatoriopsis* and *Palaeoscytonema* are rare in occurrence.

Eomycetopsis, the fungal form is encountered quite often. The form of *Eomycetopsis* are usually solitary. Rarely they are arranged in mass of woven parenchyma.

Orygmatosphaeridium, *Vavosphaeridium*, *Protosphaeridium*, *Kildinella*, *Nucellosphaeridium* and *Tasmanites* are common. Other forms are rare. The acritarch assemblage is characterised by the absence of Acanthomorphitae.

In recent years microbiota containing only acritarchs have been described from the Vindhyans of Rajasthan (Salujha, Rehman & Rawat, 1971) and Son Valley (Salujha, Rehman & Arora, 1971). The microbiota recorded from the Upper Vindhyan sequence exposed in the Karauli and Kotah areas of Rajasthan compares to the microbiota assemblage in the presence of following acritarch genera, viz., *Vavosphaeridium*, *Symplassosphaeridium*, *Protosphaeridium*, *Lophosphaeridium*, *Zonosphaeridium* and *Tasmanites*. However, the acritarch assemblage from Rajasthan has *Cymatiosphaera*, *Dictyotidium*, *Priscogalea*, *Leiovalia*, *Ooidium*, *Arcaeohystrichosphaeridium* and *Leioligotriletum* which are absent in Suket Shales.

TABLE 1 — SHOWING PERCENTAGE FREQUENCY OF MICROBIOTA IN SUKET SHALES, RAMAPURA

ALGAE		
	Aphanocapsaopsis	8·5%
	Myxococcoides	27·5%
	Palaeoanacystis	5·5%
FUNGI		
	Eomycetopsis	11·0%
ACRITARCHS		
	Protosphaeridium	6·0%
	Granomarginata	2·0%
	Orygmatosphaeridium	25·5%
	Vavosphaeridium	9·0%
	Kildinella	6·0%
	Archaeofavosina	0·5%
	Nucellosphaeridium	1·5%
	Tasmanites	0·5%

Moreover, the Suket Shales microbiota shows the presence of filamentous and, colonial algae belonging to Cyanophyceae which are so far unknown from Rajasthan flora.

The microbiota recorded by Salujha, Rehman and Arora (1971) from the Vindhyans exposed along the Son Valley in Uttar Pradesh and Madhya Pradesh compares to the microbiota of Suket Shale in the presence of *Vavosphaeridium*, *Protosphaeridium*, *Lophosphaeridium*, *Archaeofavosina*, *Zonosphaeridium* and *Tasmanites*. However, the recorded forms of Acanthomorphitae from Son Valley are unknown from Suket Shales.

The microbiota of the Suket Shales, Vindhyan show a close akinness to the Upper Bushimay |System of Kanshi Zaire, Late Pre-cambrian (Maithy, 1975) due to occurrence of algae, fungi and acritarchs. The genera of acritarchs and fungi are common in both the assemblages. The common algal forms in both the assemblages are *Palaeoanacystis* and *Myxococcoides*. But the Zaire Assemblage has large number of other algal forms, viz., *Gunflintia, Siphonophycus, Sphaerophycus, Chlorogloeaopsis* and *Glenobotrydion*, which are absent in Suket Shales. The above named forms are of filamentous type.

In recent years Schopf (1968) and Schopf and Blacic (1971) have described microbiota from the Late Pre-cambrian and Bitter Spring Formation of Australia which shows a dominance of filamentous and coccoid blue-green algae. The microbiota of the Suket Shales agree with that of Bitter Spring by the presence of *Myxococcoides, Palaeoanacystis, Oscillatoriopsis* and the fungi *Eomycetopsis*. However, the septate filamentous algal forms (*Palaeolyngbya, Calyptothrix, Cyanonema, Cephalophytarion*, and *Glenobotrydion*); other non-filamentous forms (*Archaeonema* and *Tenuifilum*) and the colonial forms (*Sphaerophycus*) are absent in Suket Shales. Moreover, in Suket Shales acritarchs are present which are totally absent in the Bitter Spring Formation.

A rich microbiota containing acritarchs have been reported by Naumova (1960, 1974); Timofeev (1959, 1966, 1970a, 1970b, 1973); Volkova (1968, 1969a, 1969b, 1974); Shepeleva (1973); Pykhova (1973); Rudavaskaja (1973); Andreyeva (1973); Iltchenko (1973) and Lopukhin (1971, 1973, 1974) from the Late Pre-cambrian and Cambrian of USSR, Konzalova (1972, 1973, 1974a, 1974b, 1974c) from the Pre-cambrian of Czechoslovakia, Downie (1974) from the Lower Cambrian and Pre-cambrian of Norway, Greenland and Scotland and Vanguestaine (1973) from Upper Cambrian of Belgium. A critical analysis shows that the acritarchs in Late Pre-cambrian (Riphean) show dominant occurrence of Sphaeromorphitae while the acanthomorphs are extremely rare. The acanthomorphs are commonly known from the Cambrian and onwards. This has also been observed by Timofeev (1966, 1973). The Upper Riphean microbiota of Russia and that of Suket Shales, Vindhyan agree by the common occurrence of *Protosphaeridium, Symplassosphaeridium, Granomarginata, Orygmatosphaeridium, Kildinella, Vavosphaeridium, Archaeofavosina* and *Nucellosphaeridium*. However, several other forms known from the upper Riphean, *Leilogotriletum, Ooidium, Zonoodium* and others are not known from the Suket Shales. The information about the microbiota from Czechoslovakia, Norway, Greenland and others are not well known, hence, a detail comparison is not possible.

Age of Suket Shales

The age of the Vindhyan sediments has been one of the major problems confronting to the geologists and palynologists in India. Oldham (1893) suggested a Cambrian age. Auden (1933) opined that the age of Vindhyan can be anything from Algonkian to Devonian. Rode (1946) indicated an early Palaeozoic age for the Rohtas Limestone. Misra (1949) on the basis of primitive form of Dasycladous algae from the same zone suggested a Devonian age. Sitholey, Srivastava and Verma (1953) have described the remains of algae and fungal spores found in the Upper Vindhyan beds assigning them to a Cambrian age. Krishnan (1968) believes that the Vindhyan may be mainly Cambrian in age. The study of the stromatolites from the Vindhyachal by Valdiya (1969) reveals that the Lower Vindhyan stromatolites from the Son Valley are comparable to the Lower Riphean, Burzyan series of southern Urals of the USSR, which is regarded older than 1260 million years. Recently, Salujha (1973) concluded that the age of whole Vindhyan sequence ranges from Late Pre-cambrian to Early Silurian and independently the Lower Vindhyan are assigned an age from Late Pre-cambrian to the middle part of Cambrian whereas the Upper Vindhyans range in their age from Late Cambrian to Early Silurian.

The Suket Shales from Ramapura, stratigraphically represent the uppermost part of the Lower Vindhyan, Semri Series (Shrivastava, 1972). The microbiota as discussed earlier shows close comparison to the Late Pre-cambrian microbiota of Bitter Spring Formation of Australia in the presence of algal and fungal remains and on the basis of acritarchs to the Upper Riphean of USSR.

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EXPLANATION OF PLATES

(All magnifications × 500, unless mentioned)

PLATE 1

1. *Myxococcoides ramapuraensis* sp. nov.; Slide. regd. no. 4928.
2. *M. globosa* sp. nov.; Regd. no. 4929.
3. *M. magnus.* sp. nov.; Regd. no. 4930, × 250.
4. *Palaeoanacystis suketensis* sp. nov.; Regd. no. 4931.
5. *P. punctatus* sp. nov.; Regd. no. 4931.
6. *P. verucosus* sp. nov.; Regd. no. 4931.
7. *P. reticulatus* sp. nov.; Regd. no. 4932.

8-9. *Aphanocapsaopsis sitholeyii* gen. et sp. nov.; Regd. no. 4929.

10-11. *A. ramapuraensis* sp. nov.; Regd. no. 4929.

PLATE 2

12. *Oscillatoriopsis psilata* sp. nov.; Regd. no. 4929.

13-14. *Palaeoscytonema srivastavae* gen. et sp. nov.; Regd. no. 4934, 4931.

15. *Eomycetopsis psilata* sp. nov.; Regd. no. 4931.
16. *E. pflugii* sp. nov.; Regd. no. 4933.
17. *E. reticulata* sp. nov.; Regd. no. 4934.
18. *Protosphaeridium volkovae* sp. nov.; Regd. no. 4934.
19. *Protosphaeridium densum* Maithy. Regd. no. 4934.
20. *Symplassosphaeridium bulbosum* sp. nov.; Regd. no. 4932.

PLATE 3

21. *Kildinella suketensis* sp. nov.; Regd. no. 4934.
22. *Kildinella minuta* sp. nov.; Regd. no. 4934.
23. *Granomarginata rotata* sp. nov.; Regd. no. 4929.

24-25. *Archaeofavosina reticulata* sp. nov.; Regd. no. 4934, 4929.

26. *Orygmatosphaeridium plicatum* sp. nov.; Regd. no. 4938.

PLATE 4

27. *Vavosphaeridium reticulatum* sp. nov.; Regd. no. 4931.

28. *Zonosphaeridium punctatum* sp. nov.; Regd. no. 4931.

29. *Nucellosphaeridium zonatum* sp. nov.; Regd. no. 4931 × 250.

30-31. *Nucellosphaeridium minimum* sp. nov.; Regd. no. 4931, 4020.

32. *Tasmanites vindhyaensis* sp. nov.; Regd. no. 2804, × 15.

33. A portion of *T. vindhyaensis* enlarged to show structure, × 200.

PLATE 5

34. cf. *Kakabekia* sp. nov.; Regd. no. 4929.

35. Type-2, B.S.I.P. No. 25198/8, × 16.

36. Type-3, B.S.I.P. no. 25209, × 16.

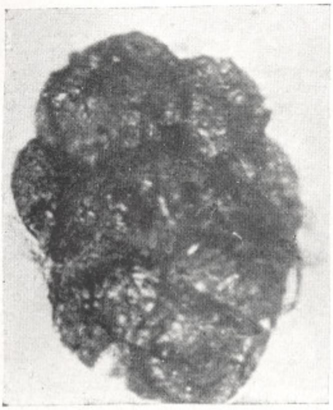
37. Type-1, B.S.I.P. no. 25198/A, × 16.

38. Type-4, B.S.I.P. no. 25193, × 16.

39. Type-5, B.S.I.P. no. 25197, × 16.

40. Type-6, B.S.I.P. no. 25204, × 16.

41, 42. Macerated discs of *Fermoria*. Regd. nos. 4926, 4927, × 100.



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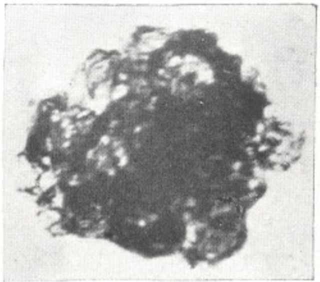

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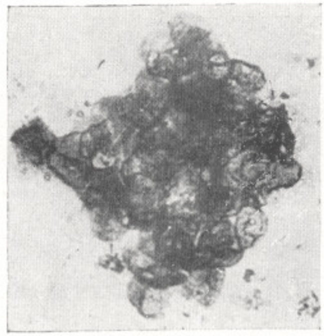

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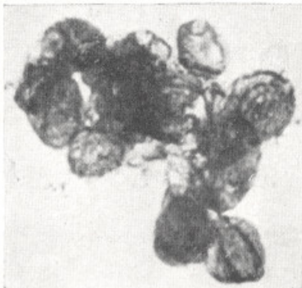

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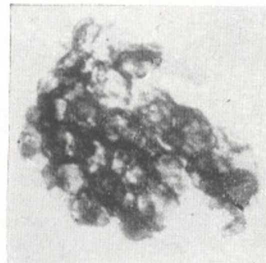

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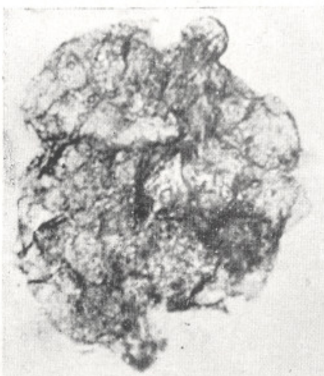

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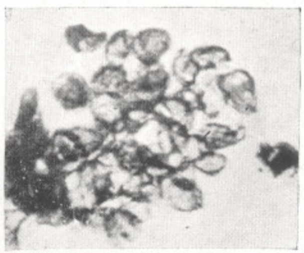

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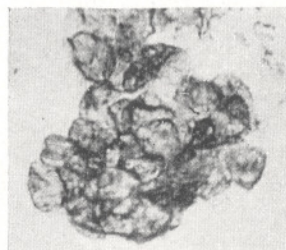

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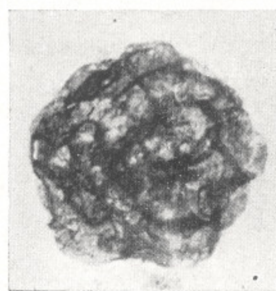

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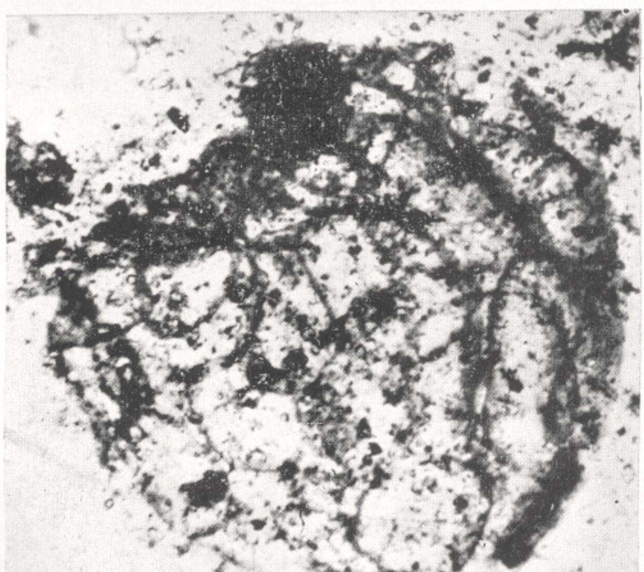

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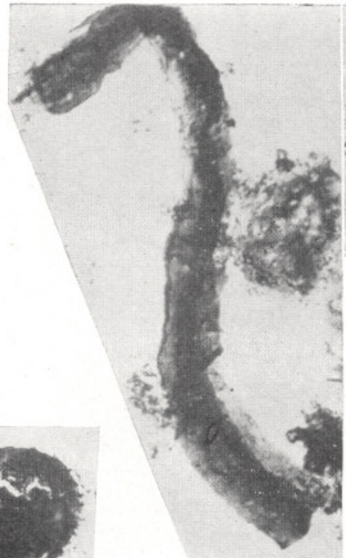

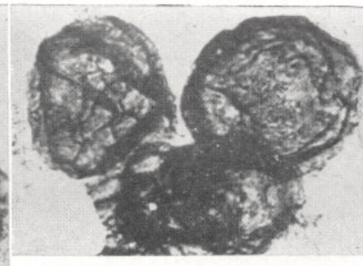

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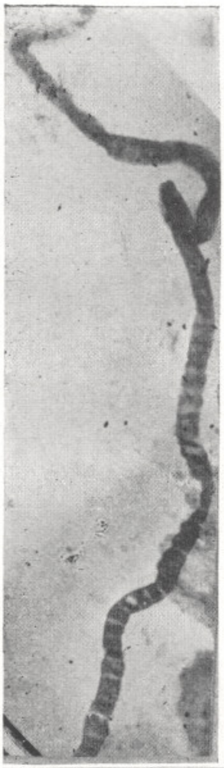

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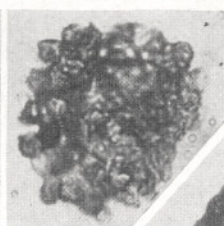

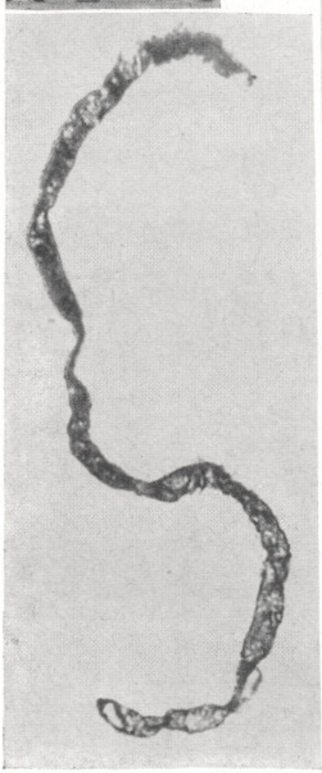

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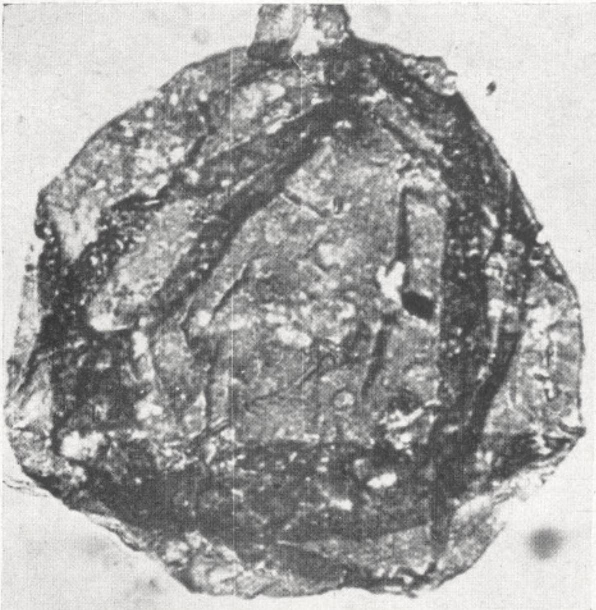

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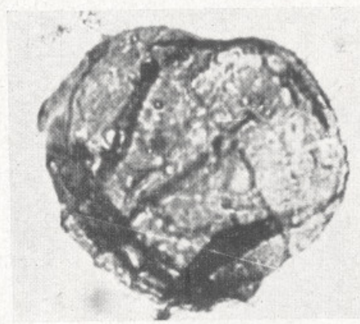

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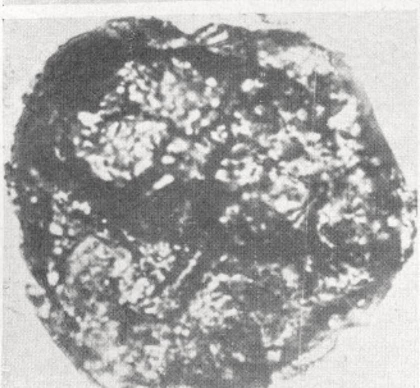

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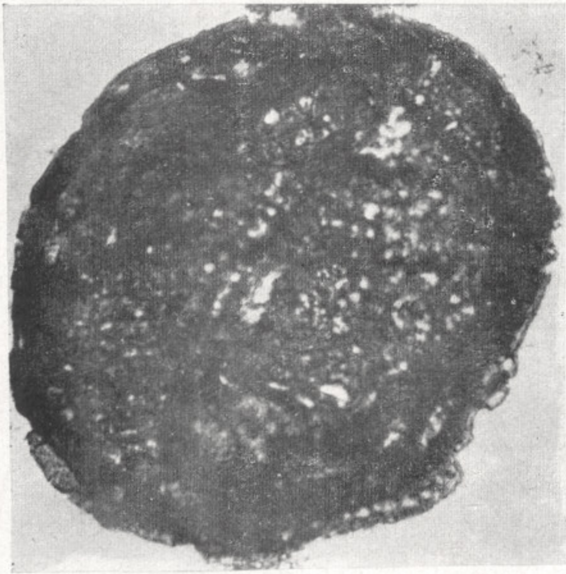

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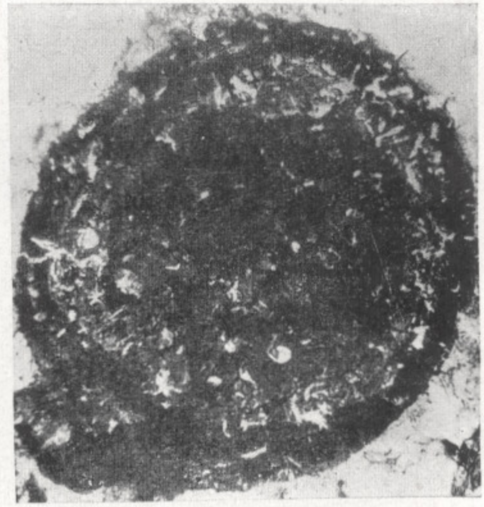

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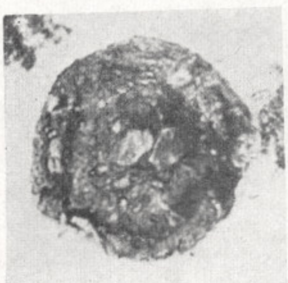

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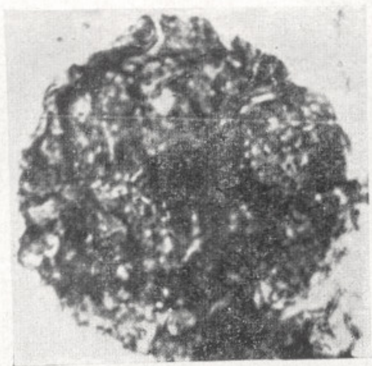

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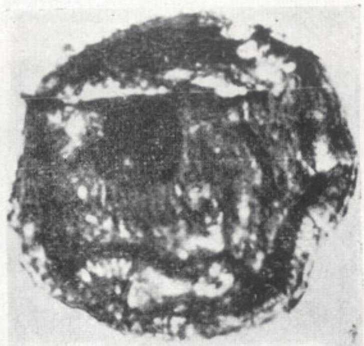

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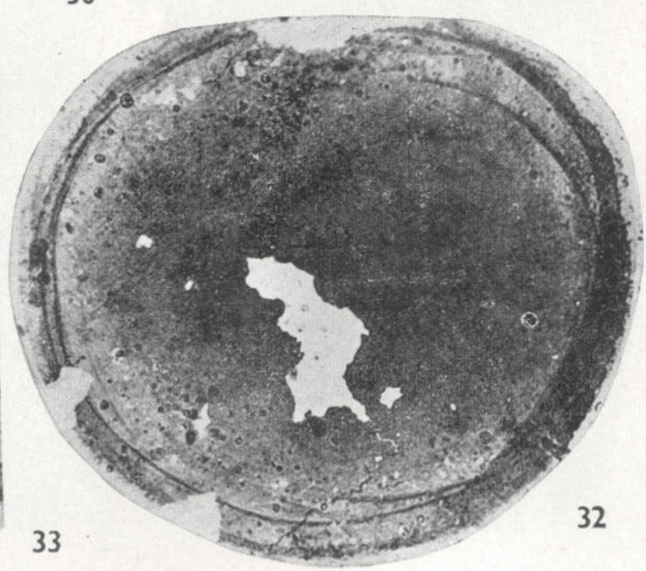

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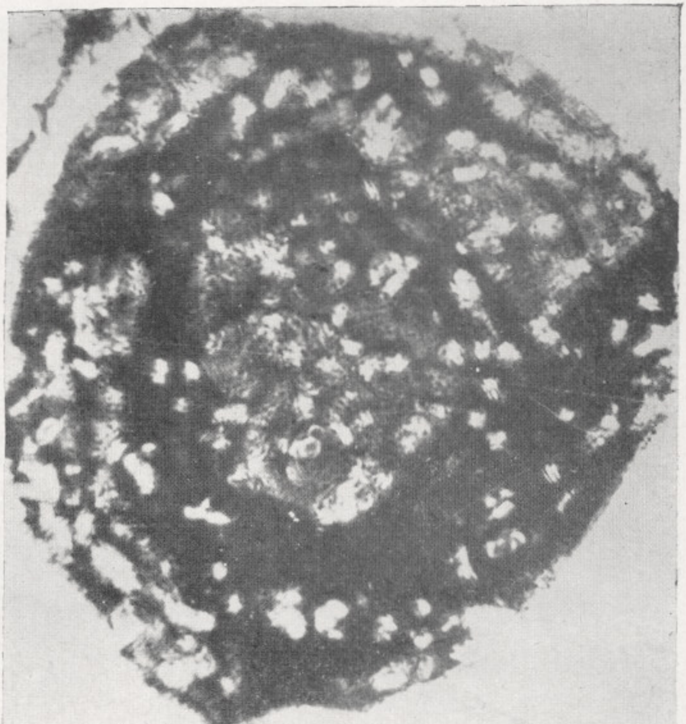
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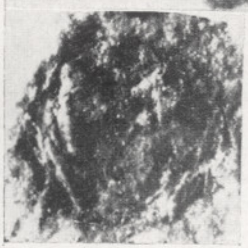
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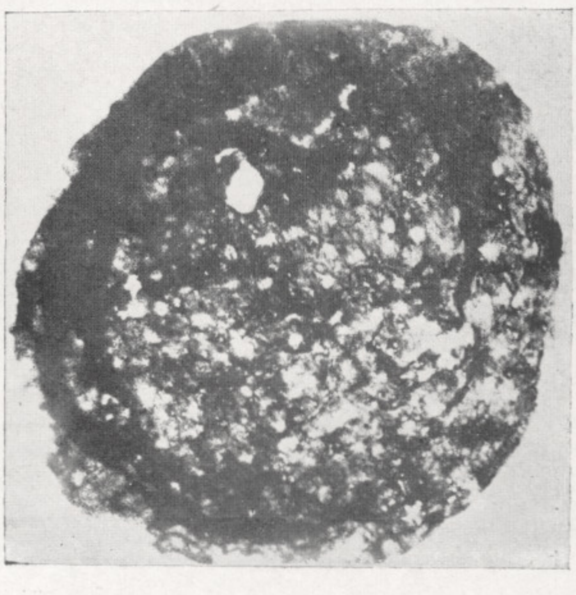
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