PALYNOLOGY OF THE MARINE INTERCALATIONS IN THE LOWER GONDWANA OF MADHYA PRADESH, INDIA

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ABSTRACT

Associations of miospores and marine acritarchs are described from the marine intercalations in the Lower Gondwanas near Manendragarh and Umaria. The Manendragarh mioflora is typically Talchir in its dominating content of monosaccate forms. Associated acritarchs are very rare. The Umaria assemblage is poor in miospores but marine acritarchs are abundant amongst which *Foveofusa* gen. nov. is distinguished. The palynological, biostratigraphical and environmental aspects of the palynological associations are briefly discussed.

INTRODUCTION

NEAR Manendragarh and Umaria (Madhya Pradesh), the lower members of the Lower Gondwana include a small thickness of marine strata which constitute evidence of marine transgression in India. Similar occurrences are now known from the Talchirs of the Daltonganj Coalfield (Bihar) and from other more or less equivalent strata in the extra-Peninsula (Text-fig. 1). In most of these patches a marine invertebrate fauna has been found which is believed to indicate a Lower Permian age. Microfaunal remains have also been recorded from some of the marine patches. Unfortunately, however, we had, till recently, no knowledge about the palynological contents of these sediments.

The marine patches of Madhya Pradesh have in recent years received particular attention. Sastry & Shah (1964) have now advanced a new view that the marine beds of Manendragarh and Umaria represent two distinct transgressions which could be distinguished by their stratigraphical position, faunal contents and palaeogeographical setting. The Manendragarh beds are close to the lower limit of the Talchir Stage and are older than the Umaria beds which appear to fringe on the Talchir-Karharbari boundary. Previous contributions to the geological aspects of these marine beds have been already reviewed by us (Lele & Chandra, 1969).

In view of the great interest attached to the Lower Gondwana marine strata a palynological exploration of these sediments was taken up by us which resulted in the discovery of miospores and marine acritarchs at Manendragarh as well as Umaria. The findings were preliminarily recorded along with certain field geological observations (Lele & Chandra, 1969). Detailed investigation of the palynological associations were subsequently followed for the better identification of the acritarch remains in particular; for very little is known about such fossils from the Lower Gondwana formation of India. The present study, besides improving some of the previous identifications has now revealed that the Umaria microfossil association is dominated by a new type of acritarch for which *Foveofusa* gen. nov. is erected.

MATERIAL AND METHOD

Geological background of material

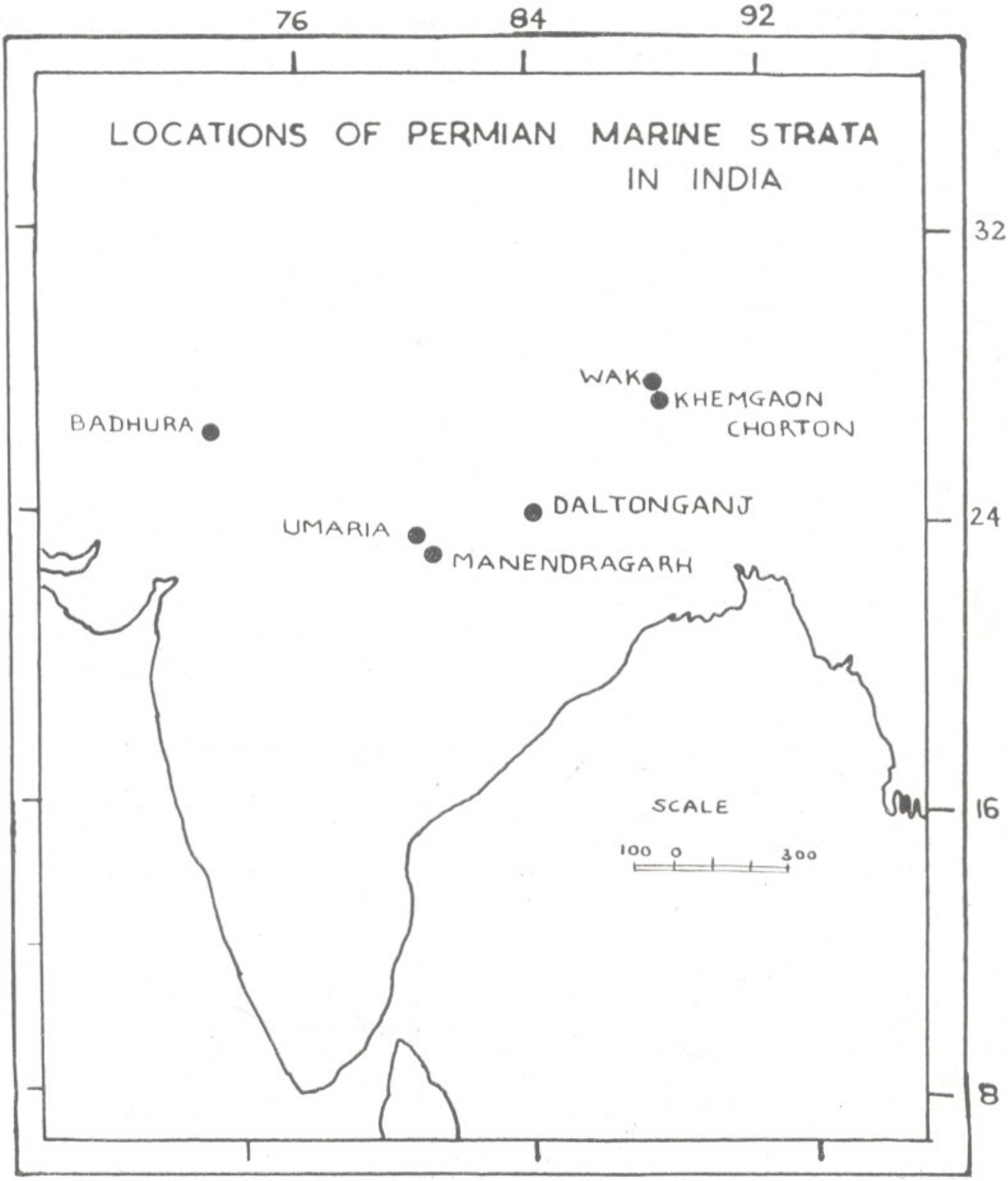
1. Section about two and a half miles west of Umaria Railway Station (Toposheet No. 64 A/14).

Talchir	4. Reddish shales	—	10 ft.
	3. Hard calcareous band (containing rich fauna and microfossils)	—	$3\frac{1}{2}$ ft.
	2. Greenish clay and shales	—	10 ft.
	1. Green and Red sandy to clayey shales etc.	—	30 ft.

The above section belongs to the upper part of the Talchir Stage. The palynological fossils were obtained from Bed No. 3. (Hard calcareous band) which is also rich in Productid fauna.

2. Section about one mile south east of Manendragarh Railway station at the confluence of Hasia Nala and Chainpur — Karimati Road (Topo-sheet No. 64 I/4).

Talchir	3. Sandstone (Yellowish greenish)	—	—
	2. Needle shales	—	7 ft.
	1. Black shales (poor in miospores, rich in animal fossils)	—	10 ft.



TEXT-FIG. 1. Location of Permian marine strata in India.

The lowest bed (Black shale) of the above section has yielded the miospore assemblage described here. The bed is also rich in Eurydesmid fauna. The overlying needle shales and sandstones did not yield any plant microfossils. The section appears to correspond with the uppermost three beds of the Manendragarh section noted by Sahni and Dutt (1959).

Maceration — The Manendragarh material of black shale was treated with Hydrofluoric acid. The Umaria material was oxidised in commercial nitric acid followed by mild alkali treataent. The microfossils (mainly Acritarchs) could be better recognised after staining with safranin.

DESCRIPTION

A. Miospores of Manendragarh

In the Manendragarh marine sequence the black shales yielded a small amount of plant spores. Among the acritarchs, which are very rare, only one could be identified (p. 6).

The recognisable miospores belong to the well known genera and species of the Talchir Stage. They are systematically listed below:

Genus *Punctatisporites* (Ibr.) Pot. & Kr. 1954

1. *Punctatisporites ganjrensis* Lele & Maithy, 1969.

Genus *Pachysaccus* Lele & Maithy, 1969

2. *Pachysaccus* sp.

Genus *Plicatipollenites* Lele, 1964

3. *Plicatipollenites indicus* Lele, 1964.
4. *Plicatipollenites gondwanensis* (Balme & Henn.) Lele, 1964.

Genus *Potonieisporites* Bharadwaj, 1964

5. *Potonieisporites* sp.

Genus *Parasaccites* Bharad. & Tiwari, 1964

6. *Parasaccites obscurus* Tiwari, 1965.
7. *Parasacites diffusus* Tiwari, 1965.

Genus *Caheniasaccites* Bose & Kar, 1966

8. *Caheniasaccites ovatus* Bose & Kar, 1966.

Genus *Faunipollenites* Bharadwaj, 1962

9. *Faunipollenites* sp.

B. Miospores of Umaria

The Umaria marine bed is very poor in miospore content, but is strikingly rich in acritarch microfossils. In the assemblage only two miospore species could be identified. These are 1. *Parasaccites obscurus* Tiwari, 1965 and 2. *Caheniasaccites granulatus* sp. nov. The new species is described below:

Anteturma — ***Sporites* H. Potonie, 1893**
Turma — ***Saccites* Erdtman, 1947**
Subturma — ***Monosaccites* Pot. & Kr., 1957**
Infraturma — ***Amphisacciti* Lele, 1965**
Subinfraturma — ***Caheniasacciti* Bose & Kar, 1966**

Genus — ***Caheniasaccites* Bose & Kar, 1966**

Type species — *C. flavatus* Bose & Kar, 1966.

Caheniasaccites granulatus sp. nov.

Pl. 1, Fig. 1

Diagnosis — Size range 76-120 $\mu \times$ 40-62 μ; miospores oval; body mediumly thick, outline not very sharp, circular to subcircular, 24-55 μ in size, granulate; monolete ill-defined; saccus detachment zones subequatorial, saccus laterally very narrow, $\pm$ constricted, may form a collar; saccus intrareticulation medium.

Comparison — The known species are larger in their size range and differ in respect of body ornamentation.

Holotype — Pl. 1, Fig. 1.

Type locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

C. Acritarchs of Umaria

Group — ***Acritarcha* Evitt, 1963**
Sub-group — ***Sphaeromorphitae* Downie, Evitt & Sarjeant, 1963 (al. *Leiosphaeridae* Eisenack, 1954)**

Genus — ***Leiosphaeridia* (Eis.) Downie & Sarjeant**
Eisenack, 1958
Downie & Sarjeant, 1963
Pro-Synon.: *Leiosphaeridium* (Timofeev) 1959 ex. Staplin, 1961

Type Species — *Leiosphaeridia baltica* Eisenack, 1958; Lower Palaeozoic, Europe, U.S.A.

Leiosphaeridia indica sp. nov.

Pl. 1, Fig. 2

Diagnosis — Vesicles spherical to subspherical, 50-170 μ, smooth to infra-structured, without external ornamentation, pores or canals. Irregular folds usually on the periphery, wall thin.

Comparison — *Leiosphaeridia* is used here in the sense of Staplin, Jansonius and Pocock (1965).

Among the Gondwanaland species, *Leiosphaeridia indica* sp. nov. is distinguishable from *L. crescentica* Sinha (1969) and *L. simplex* Sinha (1969) in respects of size, wall thickness or compression fold pattern. Probably nearest to *L. indica* sp. nov. is a form described as *Leiosphaeridia* sp. by Maithy (1969) from the Vindhyans. *Leiosphaeridia* sp. of Segroves (1967) has a wider size-range and a relatively thicker wall that is heavily folded.

Holotype — Pl. 1, Fig. 2.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Leiosphaeridia umariensis sp. nov.

Pl. 1, Fig. 3

Diagnosis — Vesicles spherical, 30-40 μ, wall thin, without sculpture, minor folds present, pylome not observed.

Comparison — *Leiosphaeridia crescentica* Sinha (1969) is comparable in size-range but is distinguishable by big semicircular fold on the wall.

Holotype — Pl. 1, Fig. 3.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Leiosphaeridia sp.

Pl. 1, Fig. 4

Remarks — Solitary vesicle, spherical, size 15 μ. Wall very thin. Perhaps such small-sized specimens could be assigned to *Protoleiosphaeridia* as has been adopted by Staplin et al (1965), but the present material is not enough to determine this point. *Protoleiosphaeridium* sp. described by Maithy (1969) is larger.

Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Genus — *Trachyminuscula* Naumova, 1937

Trachyminuscula sp.

Pl. 1, Figs. 5, 6

Remarks — Ornamented alete spheres with irregular thickenings are included under this Lower Palaeozoic genus. The figured specimens show a crowded sculpture of very small grana to coni and bear close resemblance to *Trachyminuscula*.

Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Genus — *Margomassulina* Naumova 1937

Margomassulina sp.

Pl. 1, Figs. 7, 8

Remarks — Square to rectangular cells, isolate or in groups, with irregular surface thickenings have been assigned to this genus occurring in the Lower Palaeozoic of Russia. In the present material such squarish to rectangular cells (± 20 μ in size) have been found in groups of four (Fig. 7) as well as in isolation (Fig. 8).

Locality — Narsarha Nala Umaria, M.P.

Horizon — Talchir Stage (Marine Bed).

Genus — *Protomassulina* Naumova 1937

Protomassulina sp.

Pl. 1, Figs. 9, 10

Remarks — Cellular clusters of this type with occasional marginal thickenings are comparable to those described by Lopukhin (1966) and Chepikova (1966) under the name *Protomassulina*. The specimen in Fig. 10 has more polygonal cells than that in Fig. 9. It also appears in Fig. 10 as if the cells are more or less radially arranged around a central cell which is distinctly smaller in size. It may be that the two specimens are different.

Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Sub-group— *Netromorphitae* Downie, Evitt & Sarjeant, 1963 (al. *Leofusidae* Eisen. 1938)

Genus — *Foveofusa* gen. nov.

Diagnosis — Vesicles hollow; outline subcircular-oval, rectangular or lenticular. Terminal ends truncate, rounded or attenuated. Wall single layered, thick to thin. Endwalls may be relatively thinner giving rise to compression folds parallel to shorter axis near terminal ends. Other compression folds may be present. Wall surface characteristically pitted and often finely striated. Pits variable in shape, size, distribution and orientation.

Geno-type — *Foveofusa perforata* sp. nov.

Description — The wide variation in form and size is one of the characteristics of this fossil. More prevalent forms are ± rectangular with truncate to rounded ends. Variations on the one extreme lead to squarish or subcircular forms whereas on the other extreme the vesicles tend to become more narrow and elongated with tapering or attenuated terminal ends. The whole range of variations, however, seems to constitute a homogeneous group of acritarchs characterised by a pitted and often finely striated wall.

The pits are distinct to indistinct, generally sparsely distributed and vary in shape from nearly circular to oval-elliptical or slit-like. They are often well recognisable on the surface and occasionally may appear along the profile of the vesicle (Pl. 1, Fig. 14; Pl. 2, Fig. 18). Further, the slit-like or elliptical pits may show preferred orientation parallel to the shorter or longer axes of the vesicle. Besides perforations, the vesicle wall may bear fine striations running parallel to the longer axis. Occasionally the striations appear to be replaced by or associated with fine longitudinal folds. These wall details can be better detected and studied under higher magnification.

The vesicle wall is single layered, generally more or less translucent and thick and takes safranin stain firmly. Overmacerated vesicles take lighter stain and apparently lose details of wall characters.

The end-wall of some vesicles was probably thinner than the longitudinal wall. This is borne out by the compression folds often developed parallel to the shorter axis near the two terminal ends of the vesicle. Longitudinal compression folds may also develop on the wall of certain more elongated or rectangular vesicles. Squarish to sub-circular vesicles may have irregular compression folds. The vesicles were probably oval to round in cross section.

Delimitation of species was often difficult in view of the more or less gradational tendency in the range of variations. A combination of criteria was used in distinguishing the types. More useful criteria are (1) the shape, size, distribution and orientation of the pits (2) nature of striations (3) overall shape and (4) length/breadth ratios of vesicles.

Comparison — *Quisquilites* Wilson and Urban (1963) compares in being perforated but it is distinct in possessing a two-layered wall penetrated by canals as revcaled by its ultrastructure (Wilson & Urban, 1971). The trend of shape variations in *Quisquilites* is also different from that of *Foveofusa* gen. nov. Other genera such as *Leioaletes* Staplin (1960), *Ellipsalates* Cramer (1966) and *Deusilites* Hemer & Nygreen (1967) are devoid of pits on the vesicle wall. *Leiofusa* Eisen (1938). also lacks wall perforations and the vesicle is typically fusiform, often bearing a process at each pole.

Foveofusa perforata sp. nov.

Pl. 1, Figs. 11-13; Text-fig. 2

Diagnosis — Size range 36-105 μ × 100-350 μ, vesicles translucent, outline elongate-rectangular. Length usually much greater than twice breadth. Longer sides ± parallel or slightly tapering towards ends. Wall thick, often producing a 2-6 μ wide peripheral border. End walls truncate to bulged, not appreciably thinner than longitudinal wall. Compression folds may develop along margin. Pits 0·5-1·5 μ in diameter, fine, generally ± circular, sparsely distributed. Striations indistinct, fine, parallel to longer axis, about 6-8 μ apart, occasionally associated with longitudinal folds.

Remarks — The forms are characterized by their conspicuously elongated shape, ± circular pits and the preferential development of compression folds along the margin. The wall may show a thicker border due to the marginal compression folds. Other regions of the wall are rarely folded.

Holotype — Pl. 1, Fig. 11; Text-fig. 2.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Foveofusa cylindrica sp. nov.

Pl. 1, Fig. 14; Pl. 2, Fig. 19; Text-fig. 3

Diagnosis — Size range 100-200 μ × 50-65 μ. Vesicles ± transparent. Outline elongate ± rectangular. Length twice or usually greater than twice breadth. Wall moderately thin, peripheral folds usually not developed. End walls generally ± flat, rarely bulged, probably somewhat thinner than longitudinal walls, producing terminal

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TEXT-FIGS. 2-8 — 2. *Foveofusa perforata* gen. et sp. nov. Drawing of the holotype. × 375 3. *Foveofusa cylindrica* gen. et sp. nov. Drawing of the holotype. × 375. 4. *Foveofusa obesa* gen. et sp. nov. Drawing of the holotype. × 375. 5. *Foveofusa pumila* gen. et sp. nov. Drawing of the holotype. × 375. 6. *Foveofusa mutabilis* gen. et sp. nov. Drawing of the holotype. × 375. 7. *Foveofusa attenuata* gen. et sp. nov. Drawing of the holotype. × 225. 8. *Foveofusa* sp. Drawing of the specimen in Pl. 2, fig. 27. × 375 compression folds. Other secondary folds may be present. Pits 1-2 μ long, usually elliptical, few sub-circular; fairly numerous, well-spaced, longer axes of pits often orientated parallel to shorter axis of vesicle. Striations weak to absent.

Comparison — *F. cyclindrica* sp. nov. is distinguished from *F. perforata* sp. nov. and *F. obsesa* sp. nov. by the presence of elliptical pits showing preferred orientation.

Holotype — Pl. 1, Fig. 14; Text-fig. 3.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Foveofusa obsesa sp. nov.

Pl. 1, Fig. 15; Pl. 2, Fig. 16; Text-fig. 4

Diagnosis — Size range 96-180 μ × 54-125 μ. Vesicles translucent to transparent. Outline broadly rectangular. Length usually less than twice breadth. Wall moderately thin. End walls often bulged, rarely flat, probably thinner than longitudinal walls, producing compression folds near terminal ends. Other compression folds common, generally irregular, occasionally parallel to longer axis. Pits up to 1-2·5 μ (longer dimension), subcircular-elliptical, very sparse and fewer for the size of the vesicle. Striations indistinct, fine about 10 μ apart.

Comparison — *F. perforata* sp. nov. is distinguished from the present species by its conspicuously elongated shape (length usually much greater than twice breadth), larger number of finer circular pits, thicker wall and the general lack of compression folds on the vesicle except along its margin.

Holotype — Pl. 2, Fig. 16; Text-fig. 4.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Foveofusa pumila sp. nov.

Pl. 2, Figs. 17-18; Text-fig. 5

Diagnosis — Size range 35-125 μ × 50-90 μ. Vesicles ± transparent. Outline broadly rectangular to nearly squarish. Length less than twice breadth. Wall moderately thick, peripheral fold-border not developed. End walls ± bulged or flat, not appreciably thinner than longitudinal wall. Terminal compression folds generally absent. Other secondary folds uncommon. Pits 1·5-4μ long, oval elliptical or slit-like, fairly numerous, well-spaced, longer axis of pits generally orientated ± parallel to shorter axis of vesicle. Striations absent or very weak.

Comparison — *F. cylindrica* sp. nov. is distinguished by its more elongated shape (length greater than twice breadth), smaller size of pits and the usual presence of terminal compression folds.

Holotype — Pl. 2, Fig. 17; Text-fig. 5.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Foveofusa mutabilis sp. nov.

Pl. 2, Figs. 20-22; Text-fig. 6

Diagnosis — Size range 42-70 μ × 56-78 μ. Vesicles translucent-transparent. Outline very variable, nearly circular, oval, squarish, rectangular or polygonal. Wall thin to thick. Irregular compression folds common. Pits about 1-4 μ (longer dimension), circular, oval or elliptical, sparse, irregularly oriented, striations not observed.

Comparison — Forms are distinct from all other species by their smaller size, extremely variable shape and irregular orientation of pits and folds.

Holotype — Pl. 2, Fig. 20; Text fig. 6.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Foveofusa attenuata sp. nov.

Pl. 2, Figs. 23-26; Text-fig. 7

Diagnosis — Size range 500-1000 μ × 15-50 μ. Vesicles ± transparent. Outline very narrow-lenticular. Length conspicuously greater than width. Terminal ends tapering or drawn out, pointed to blunt. Wall thin to thick. Compression folds absent or uncommon. Pits 4-8 μ (longer dimension), commonly elliptical oval or slit-like, occasionally ± circular, sparsely spaced. Longer axis of pits often aligned parallel to the longer axis of vesicle. Longitudinal striations fine.

Remarks — The forms are strikingly filamentous in appearance. Occasionally the fossils occur in a mass or bundle (Fig. 25). The terminal ends are often considerably drawn out to a point recalling shape of some Leiofusids. In several cases the ends appear to have broken. The absence of endwalls in these fossils is in sharp contrast with other forms assigned to *Foveofusa*. However, there is a close relationship in the common presence of characteristic pits and striations.

Comparison — The forms are easily distinguishable by their narrow — elongated lenticular shape, attenuated terminal ends and more or less filamentous appearance. Besides, the fine slit-like pits are orientated along the longer axis of the vesicle (Fig. 26).

Holotype — Pl. 2, Fig. 23; Text-fig. 7.

Type Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

Foveofusa sp.

Pl. 2, Fig. 27; Text-fig. 8

Description — Size range 300-500 $\mu \times 28$-35μ. Vesicles conspiculously elongated, narrow, $\pm$rectangular. Longer sides slightly tapering towards end. End walls generally flat. Terminal compression folds or other folds nearly absent. Pits fine, 1-2 μ (longer dimension), subcircular to oval-elliptical, rarely slit-like; generally irregularly spaced, some pits may have their longer axis parallel to the longer sides of vesicle. Longitudinal striations distinct, about 5-8 μ apart.

Comparison — The forms are fewer in number but are very distinct in having prominent striations. The longer walls are generally more tapering than in other species of *Foveofusa* and in that respect *Foveofusa* sp. indicates a transition towards the distinctly lenticular forms, like *F. attenuata* sp. nov. which have no end walls. With regard to pits also, *Foveofusa* sp. suggests a transition between *F. attenuata* sp. nov. and the rest species of *Foveofusa*.

Locality — Narsarha Nala, Umaria, M.P.

Horizon — Talchir Stage (Marine bed).

D. Achritarchs of Manendragarh

Sub-group — *Herkomorphitae* Downie, Evitt & Sarjeant, 1963

Genus — *Dictyotidium* Eisenack, 1938
Type species — *Dictyotidium dictyotum* Eis. 1938 emend. Staplin, 1961

Dictyotidium sp.

Pl. 2, Fig. 28

Description — Solitary specimen; 70×50 μ; golden yellow in colour, sub-circular, wall folded, structureless; surface covered with strong muri, about 1-2μ wide, forming reticulum on both sides. Meshes 5-12μ in width, polygonal with rather sharply developed angles.

Remarks — The form is provisionally referred to *Dictyotidium*. Some resemblance is also met with *Retialetes* Staplin (1961) and *Retisphaeridium* Staplin et al. (1965) but the former genus is ellipsoidal whereas in the latter the muri of the meshes do not cross the equator.

Locality — Near the confluence of Hasia Nala and Chainpur — Karimati Road, Manendragarh, M.P.

Horizon — Talchir Stage (Marine bed).

Discussion

Palynological considerations

The Manendragarh assemblage is chiefly composed of seven miospore genera which are distributed in the following order of frequency:

Plicatipollenites	56%
Parasaccites	33%
Potonieisporites	4%
Punctatisporites	3%
Caheniasaccites	2%
Pachysaccus	1%
Faunipollenites	1%

The spore assemblage is dominated by monosaccate miospores whereas the disaccates and triletes are limited to a few examples of one or two genera. Among the monosaccates the radially symmetrical forms belonging to *Plicatipollenites* and *Parasaccites* is preponderant. Each of these genera is represented by at least two recognisable species but perhaps more species may be present. The bilaterally symmetrical monosaccates (*Potonieisporites* and *Caheniasaccites*) have a subordinate distribution.

The miospores of the Manendragarh assemblage are associated with very few examples of acritarchs amongst which only one could be provisionally identified as *Dictyotidium*. It is, however, probable that a wider search may reveal more of these microfossils.

At Umaria the situation is just the reverse. Here the assemblage is full of acritarchs but miospores are very scanty.

Among the miospores *Parasaccites* and *Caheniasaccites* could be recognised with certainty. Obviously, more information is needed for attempting palynological comparisons of the Umaria miospore assemblage with others.

The acritarch remains of Umaria provide for the first time independent support to the well known marine transgressions of the Lower Gondwana times. *Foveofusa*, the most abundant microfossil of this assemblage, finds its nearest allies in the leiofusid complex of *Leiofusa, Leioaletes, Quisquilites* and *Deusilites*. The enormous variations in size and shape exhibited by *Foveofusa* are paralleled by *Quisquilites*. Some of these leiofusids are known from the Permian sediments and *Deusilites* is especially noteworthy among them as it occurs in the Lower Gondwana of Australia. The smooth-walled leiospherids of the Umaria assemblage are of a generalized type which have wide stratigraphic range. Ornamented leiospherids are rare in the assemblage.

Biostratigraphical and Palaeo-environmental aspects

The Manendragarh and probably also the Umaria assemblage is closely comparable with other Talchir miofloras in the preponderance of monosaccate miospores. In the low diversity of miospore taxa, the Manendragarh assemblage is similar to the lower Talchir miofloras such as those of Giridih coalfield and West Bokaro Coalfield (Lele, 1966). Thus the palynological data from the Manendragarh marine intercalation is in keeping with the low geological position of the beds in the Talchir Stage. The Umaria mioflora is too poor to permit any precise stratigraphical evaluation.

From palaeo-environmental standpoint, the findings of miospores now definitely show that plants of the Glossopteris flora lived in the neighbourhood of the marine transgressive areas during the Manendragarh as well as Umaria transgressions. The cold conditions of the Manendragarh times and the progressive ameleoration of climate towards the Umaria times (as indicated by faunal assemblages), was evidently well witnessed by the flora. As regards the marine acritarchs it is striking why these microfossils should be so poorly represented in Manendragarh while they are quite conspicuous in the Umaria assemblage. As has been suggested earlier (Lele and Chandra, 1969) certain factors such as depth, temperature and salinity of the marine waters might have influenced the planktonic life in different ways. A critical palynological study of the other equivalent marine patches of India is therefore likely to provide promising clues to this interesting aspect of past environments.

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EXPLANATION OF PLATES

(All photomicrographs unless otherwise mentioned are enlarged 500 times. Slides of figured specimens are preserved in the Birbal Sahni Institute Musem. Regd. Sl. Nos 4208-4214. Manendragarh Loc. No. 935A; Umaria Loc No. 945A.).

PLATE 1

1. *Caheniasaccites granulatus* sp. nov. Sl. Regd. No. 4210 (Holotype).

2. *Leiosphaeridia indica* sp. nov. Sl. Regd. No. 4211 (Holotype).

3. *Leiosphaeridia umariensis* sp. nov. Sl. Regd. No. 4208 (Holotype).

4. *Leiosphaeridia* sp. Sl. Regd. No. 4210.

5, 6. *Trachyminuscula* sp. Sl. Regd. No. 4210.

7, 8. *Margomassulina* sp. Sl. Regd. Nos. 4208, 4211.

9, 10. *Protomassulina* sp. Sl. Regd. Nos. 4208, 4212.

11-13. *Foveofusa perforata* gen. et sp. nov. (Sl. Regd. Nos. 4209 (Holotype), 4213, 4209.

14. *Foveofusa cylindrica* gen. et sp. nov. Sl. Regd. No. 4213 (Holotype).

15. *Foveofusa obesa* gen. et sp. nov. Sl. Regd. No. 4209.

PLATE 2

16. *Foveofusa obesa* gen. et sp. nov. Sl. Regd. No. 4212 (Holotype).

17-18. *Foveofusa pumila* gen. et sp. nov. Sl. Regd. Nos. 4209, (Holotype), 4211.

19. *Foveofusa cylindrica* gen. et sp. nov. Sl. Regd. No. 4213.

20-22. *Foveofusamu tabilis* gen. et sp. nov. Sl. Regd. Nos. 4213, (Holotype), 4213, 4211.

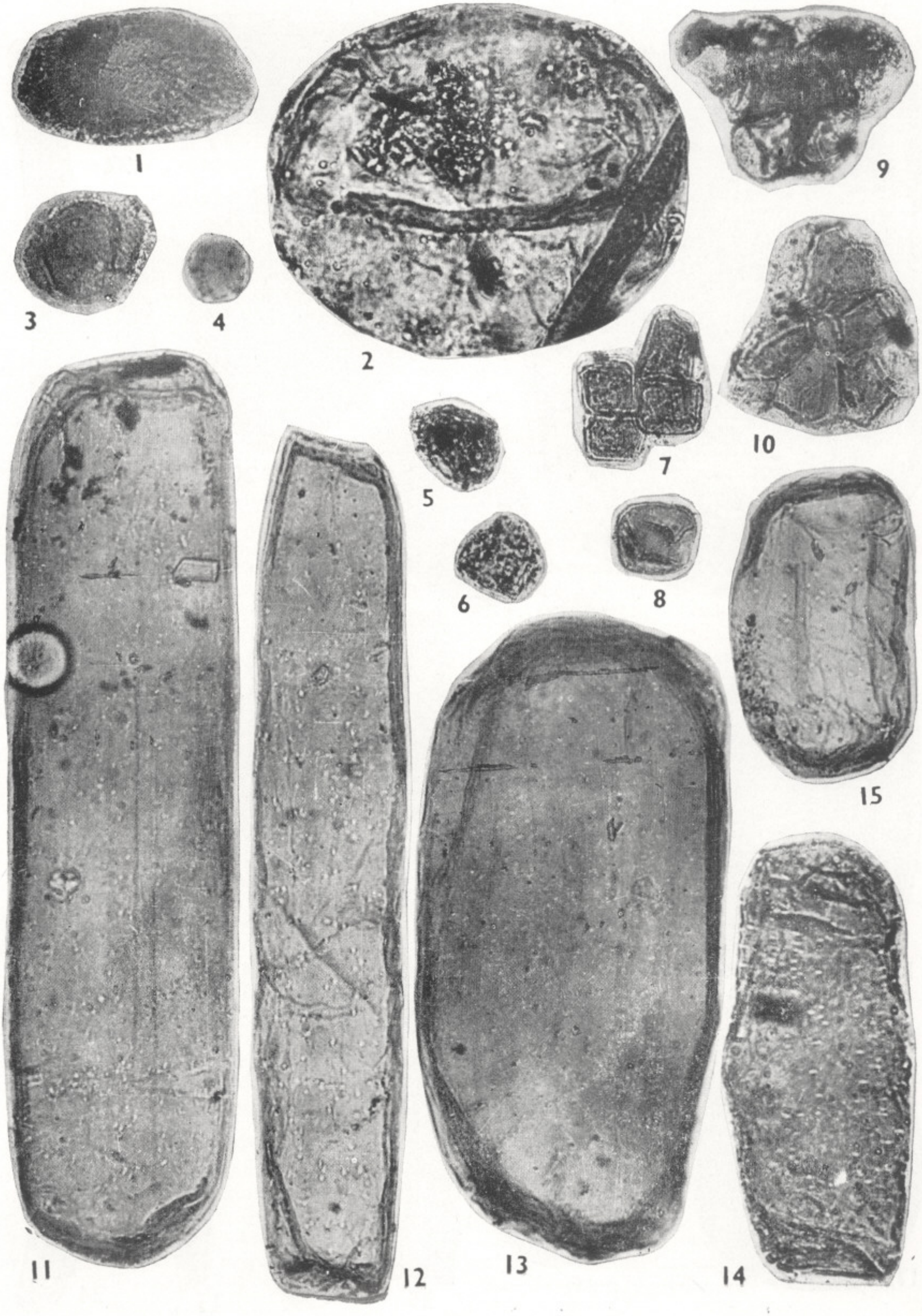
23-25. *Foveofusa attenuata* gen. et sp. nov. Sl. Regd. No. 4210 (Holotype) × 300, 4210 × 300, 4210 × 100.

26. *Foveofusa attenuata* gen. et sp. nov. Sl. Regd. No. 4210 (showing slit-like pits of fig. 24.

Figs. 23, 24 — × 300; Fig. 25 — × 100.

27. *Foveofusa* sp. Sl. Regd. No. 4213.

28. *Dictyotidium* sp. Sl. Regd. No. 4214.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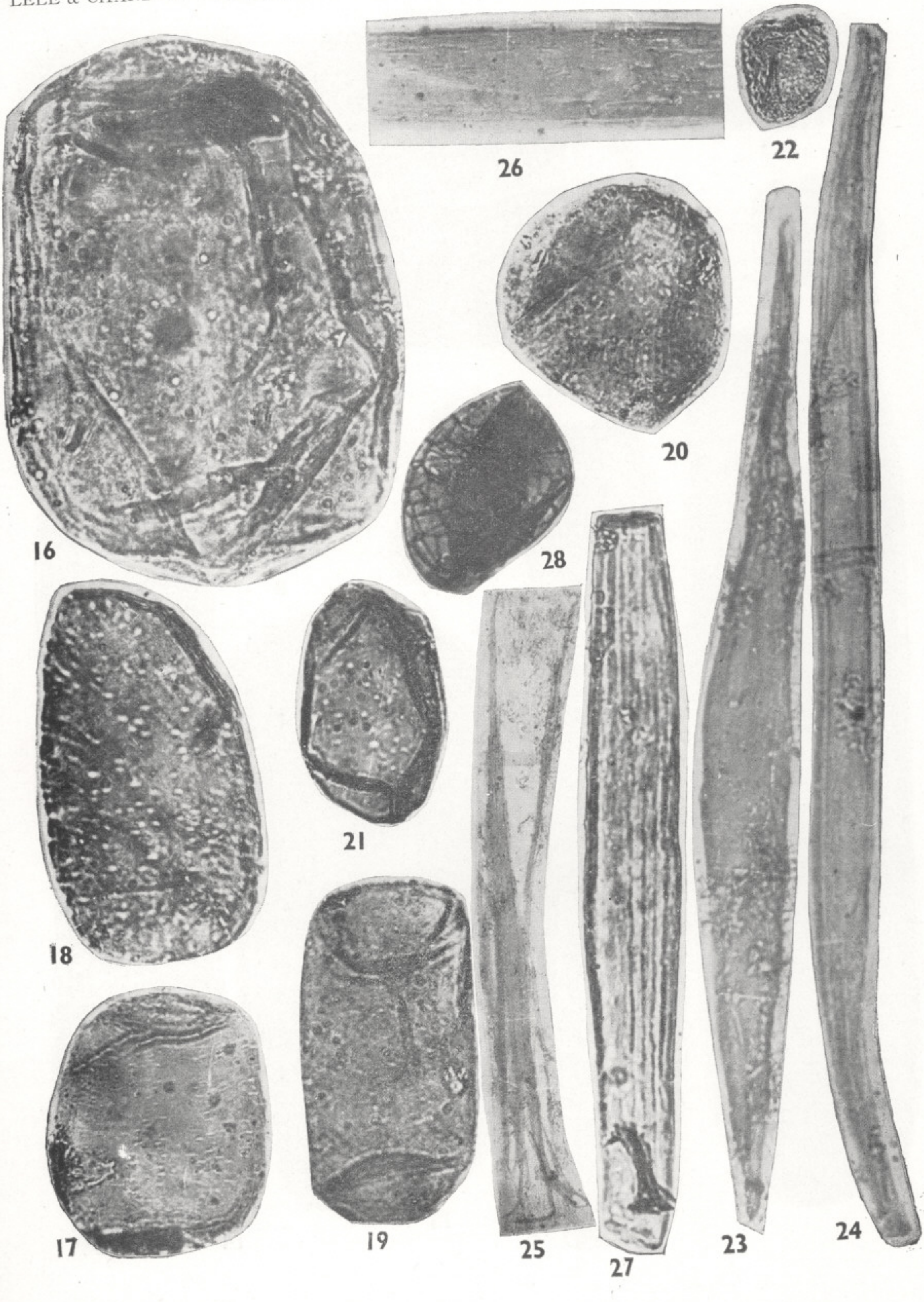
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