Journal of The Palaeontological Society of India
Vol 38, 1993, pp. 43 - 49

ORGANIC-WALLED MICROFOSSILS FROM THE GANURGARH SHALE FORMATION (BHANDER GROUP, VINDHYAN SUPERGROUP), HOSHANGABAD, MADHYA PRADESH, INDIA

P.K. MAITHY and RUPENDRA BABU
BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, LUCKNOW-226 007. INDIA

ABSTRACT

Organic-walled microfossils comprising acritarch and algae are recorded for the first time from the Ganurgarh Shale Formation of the Bhander Group of Vindhyan Supergroup, exposed at Mid-Ghat railway station, Bhopal District, Madhya Pradesh. Acritarch belonging to Sphaeromorphida show large sizes. Cyanobacterial forms are represented by elongate tubular empty sheath, septate filaments enclosed within organic sheath and globular colonies. The Leiosphaerid-Algal assemblage of the Ganurgarh Shale compares well with the known O.W.M. assemblages from the Late Riphean to Vendian strata of other countries.

INTRODUCTION

The information concerning the organic-walled microfossils from the Bhander Group of the Vindhyan Supergroup is scarce. In the past the records of the organic-walled microfossils have been documented by Salujha *et al.* (1971) from Mandral-Karauli section: Maithy and Gupta (1983) around Chandrehi; Maithy and Mandal (1983) along Sapotra Karauli section and Maithy and Meena (1989) around Satna and Maihar.

The present work details the record of the Upper Proterozoic organic-walled microfossils containing Leiosphaerid-Algal assemblage from the Ganurgarh Shale Formation (Upper Vindhyan), previously unknown from the Indian subcontinent.

MATERIAL AND METHODS

Geological details of Vindhyans from Bhopal-Hoshangabad Plateau was first published by Mallet (1989) and later by Pascoe (1959). Roy, Sharma, Sen and Bhattacharya (1981) published a geological account of this area basing upon aerial photographs. According to them. The geological succession of Vindhyan (fig. 1) in this area comprises the sequence as given in table 1.

The Upper Rewa Sandstone which underlies the Ganurgarh Shale Formation is well exposed in the studied area. The sandstone is generally light coloured (dirty white to pink) and represented by medium-fine grained orthoquartzite. The rocks show low to moderate dips. Ripple marks are profusely developed and are generally straight crested. Commonly they are asymmetric type. Tabular cross bedding is common. The overlying Ganurgarh Shale Formation is exposed on the steep scarp slopes as narrow outcrops. In the Ganurgarh Fort section, the basal 30 m portion is characterized by shales intercalated with siltstone. These are followed by the laminated shales of variegated colours which are characterized by flat-topped, symmetrical as well as interference ripple marks. Above this is the thinly laminated, light green (sometimes of chocolate colour) shaly limestone which is again overlain by variegated and splintery shales.

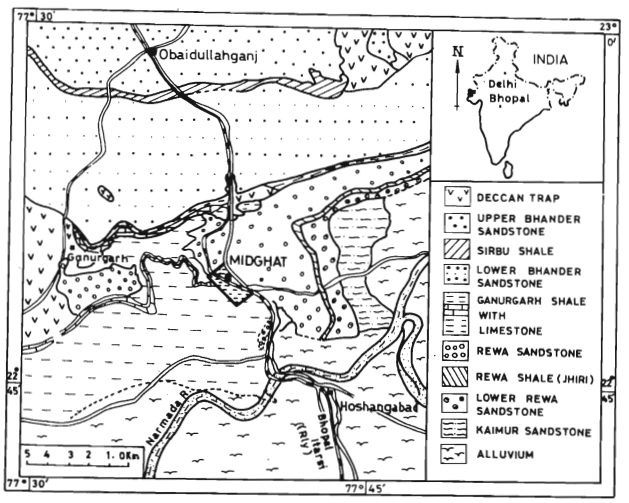


Fig. 1. Map showing geological details and location.

Table 1: Showing the sedimentary sequence in the area.

Group	Formation
	Upper Bhander Sandstaone
	Sirbu Shale
Bhander	Lower Bhander Sandstone
	Ganurgarh Shales and Limestone
	Upper Rewa Sandstone
Rewa	Jhiri Shale
	Lower Rewa quartzose Sandstnoe
	Scarp Sandstone
Kaimur	(Upper Kaimur Sandstoe)
---------- Unconformity ----------	
Archaean	

The sedimentary features in the Ganurgarh Shale Formation suggest that the lower part was deposited in a shallow logoon, and the upper part accumulated in a supratidal environment.

The Ganurgarh Shale Formation is conformably overlain by Lower Bhander Sandstone Formation. The sandstones of the latter formation are orthoquartzitic, hard, medium grained, thick bedded and flesh coloured. They show horizontal to lowly inclined disposition of beds.

The outcrops of the Ganurgarh Shale Formation are exposed along the railway cuttings which are 2 km west of the Mid-Ghat railway station of Bhopal District, Madhya Pradesh. The exposed thickness of beds is 68 m. The material was collected by one of us (R.B).

The observations are based on thin sections and macerated residue preparation of the shales. The macerated residues are better suited for study due to their clarity. Organic-walled microfossils and other disseminated organic residues display colours ranging from light to very dark-brown and in some instances nearly black. The material shows no visible traces of induced flourescence. Most processed samples are rich in Sapropel-like amorphous organic matter. This material has a granular or flanky appearance associated with pyrite pseudomorphs and extremely small (often 10 µm) pyrite framboids, which often have left clear imprints on the surface of organic flakes and sheets. The microfossils in most of the examined samples are poorly preserved and display clear traces of extensive post-mortem degradation. Most microfossils particularly spheroidal acritarch exhibit irregularly subgranular to nearly psilate surface textures which appear to be the result of vesicle wall hydrolysis under alkaline, reducing conditions. Empty filamentous cyanobacterial sheaths often display comparable degree of degradation, although few samples show relatively well preserved filamentous sheaths.

AGE OF GANURGARH SHALE FORMATION

The radiometric dates for the sediments of the Ganurgarh Shale Formation are not available. However, the dates for the overlying bed, the Lower Bhander Sandstone and the underlying bed, the Upper Rewa Quartzite, Rewa Group are known through analysis of the Glauconite (occurring in the sandstone beds) by Fission Track Method. The Lower Bhander Sandstone is dated as 625 ± 24 Ma. (Srivastava & Rajagopalan, 1988) and the Upper Rewa Quartizite is estimated at 700 ± 100Ma (Srivastava & Rajagopalan, 1989). The age of the Ganurgarh Shale Formation can be estimated by its position in the sequence and is believed to be somewhere between ± 625 Ma and ± 700 Ma.

MICROFOSSIL ASSEMBLAGE

The recorded organic-walled microfossils are remarkably simple and invariant in composition. It comprises solitary spheres belonging to Acritarch, aggregates of small globular cells forming colony comparable to Cyanophyceae, aseptate tubular filaments similar to Oscillatoriaceae and large mutlicellular sheaths.

The assemblage is dominated by Acritarch (*sensu* Timofeev, 1966). The Sphaeromorphida Acritarch forms viz., *Leiosphaeridia, Protosphaeridium, Orygmatosphaeridium, Granomarginata, Vavososphaeridium, Nucellosphaeridium* and *Cymatisophaeroides* are recorded. Vesicles of *Protosphaeridium* (pl.1, fig.3) are either solitary of in groups, sphaeroidal with smooth wall, measuring 10-13 µm. The forms are identical to *Protosphaeridium conglutianatum* Timofeev, 1958. *Leiosphaeridia* vesicle (Pl. 1, figs. 1,4) are oval in outline with irregular body folds, measuring 80-110 µm, surface thin and smooth. The specimens show akiness to *Leisophaeridia kanshiensis* Maithy (1975, pl.6, fig. 44). Vesicles of *Orygmatosphaeridium* (Pl.1, fig.9) are average in thickness, circular in outline with prominent irregular folds, surface closely pitted, measuring 80-220 µm. *Orygmatosphaeridium* forms are identical to

O. vulgarum Maithy (1975, pl.1, pl.6, fig. 45) reported from B2C of Bushimay Supergroup, Kanshi, Zaire. The acritarch measuring ± 20-80 μm with small dotted processes (Pl.1, fig.14) belong to *Granomarginata prima* Naumova, 1960. The dotted processes cover the entire surface of spheres and give broken appearance to margin; often the spheres show irregular folds. Sphere ± 20-40 μm with rounded areas measuring ± 2 μm (Pl. 1, fig. 6) compares with *Symplassosphaeridium* Timofeev. Morphologically it is similar to *S. bushimayensis* Maithy (1975) recorded from the Late Precambrian of Kanshi.

However, other large-sized spheres are globular and their size ranges upto 1000 μm. The figured specimen (Pl.1, fig.7), due to reticulate pattern on the surface agrees to *Vavososphaeridium bharadwajii* Salujha *et al.* (1971, Pl.1, Pl.1, fig. 1) reported from Maihar Sandstone. Spheres of *Nucellosphaeridium* Timofeev has distinct dark brown to black inner body, occupying nearly 1/2 or 1/3 area of the vesicle, exine of vesicle distorted and forms irregular polygonal areas (Pl.1, fig. 13). Irregular body folds are preserved. Specimens show close morphological akiness to *Nucellosphaeridium triangulatum* Maithy (1975, Pl. 6, fig. 50; Pl.7, fig. 54) recorded from the Late Proterozoic of Zaire. Vesicles (Pl.1, fig. 2) with double walled spheroidal, inner wall robust, finely granular, numerous thin (1 μm in cross sectional diameter) solid cylindrical processes arise from the inner wall and support a thin, smooth outer wall or membrane, processes regularly distributed over vesicles; no inter-connecting septa and no division of vesicle into polygonal fields by septa or membrane is referable to *Cymatiosphaeroids kullingii* Knol (1984) from the Upper Riphean (750-600 Ma) Hunnberg Formation of Nordaustlandet Svalbard.

The filamentous tubular microfossils are interpreted to be the remains of Cyanobacteria-oscillatorian forms. It is being represented by *Eomycetopsis rugosa* Maithy (1975) recorded from the Late Proterozoic of Bushimay Group. The specimens are dark brown, simple tubular filaments (Pl.1, fig. 11) non-septate, twisted and crushed, 2-9 μm wide (averaging 5 μm), fragments upto 200 μm long, solitary and clustres. Morphology is variably modified by pyrite crystallization on the surface. The other form is *Polythrichoides lineatus* Jankauskas (1990) is characterised in having several narrow tubular filaments clumped together, within a gelatinous sheath (Pl.1, fig. 15), Filaments measuring 250 μm or more in length, 2-8 μm in diameter, surface smooth to punctate. This form has earlier been reported from the Sergreevskaya Urals (Jankauskas, 1990) and Assemblage-III Upper Redkino, Valdai Series (Ragozina & Sivertseva 1990). Earlier similar forms have been figured by Maithy (1975, pl.4, figs. 27, 28) from the Bushimay Supergroup of Zaire under *Eomycetopsis cylindrica. Tubulosa corrugata* Hermann is recognised by an elgonate filament build up of cells, shorter in length andmore broader enclosed within a tubular organic sheath (Pl. 1, fig. 12).

Spherical cells, 2-8 μm aggregated in a colony; daughter colony and cells within the colony are ensheathed by a non-lamellated amorphous sheath (Pl.1, fig. 8). The form is similar to *Gloeocapsamorpha karaulinesis* Maithy & Mandal (1983, pl.1, fig. 4) recorded in Semaria Shale, Bhander Group. Beside this the other globular colonies (Pl.1, fig. 10) with compactly arranged thin-walled ensheathed cells with extremely thin hyaline sheath present around the colony are comparable to *Palaeoanacystis verrucosus* Maithy & Shukla, 1977.

The final component of the Ganurgarh assemblage includes fragments of large multicellular sheaths (Pl. 1, fig.5) displaying variable degrees of post-mortem alteration. When relatively well preserved, they appear to be completely smooth except for longitudinal and transverse folds with wrinkles. Occasionally preserved circular structures with marginal thickenings, comparable to the figured specimen of Gnilovoskya (1990, Pl. 32, figs. 1,2, 3) indicating? stomatal structures. On the other hand poorly preserved specimens display granular to fibrous structures which undoubtedly reflect advanced degree of corrosion and disintegration. The specimen agrees with the reported vendotaenid forms by Germs, Knoll and Vidal (1986).

DISCUSSION

The organic-walled microfossils of the Ganurgarh Shale Formation are characterised by the presence of Leiosphaerid-Algal complex now globaly known during the Late Proterozoic times. Uptill now similar assemblage was not known from the Indian Precambrian sediments.

In recent years, comparable assemblages have been described from the shales of the Late Proterozoic, Arcoona Quartzite Member of the Tent Hill Formation, Stuart Shelf, South Australia by Damassa and Knoll (1986) and from the grey to black shales of Kuibis and Schwarzrand subgroups of the Nama Group, South-West Africa, Namibia by Germs, Knoll

and Vidal (1986). Ganurgarh Shale assemblage agrees with the above named assemblages in the common presence of Acritarch and Cyanobacterial filaments. The most characteristic feature of Ganurgarh Shale Formation is the presence of large-sized encystment structures and small-sized Acritarch with processes. Similar comparable assemblages have also been described from the Upper Vendian rocks of Baltic region (Volkova, 1969; Korkutis, 1981), Innerlev Member of Stappogoiede Formation, east Finmark, Norway (Vidal, 1981). However, the Stappogoiede Formation also contains simple metazoan trace fossils. Similarities were also noted with the assemblage of Dengyingxia'an strata in southern China (Song-Xing, 1984). The present assemblage compares to the Late Riphean-Vendian microbiota reported from the Machhal and Lolab formations of the Putshai-Wanner Section in Kashmir, Himalaya (Maithy *et al.* 1988). But the later assemblage differs in the absence of cf. Vendotaenids. The assemblage of Bushimay Supergroup B2C, Zaire (Maithy, 1975) is more diversified in comparison to the assemblage of the Ganurgarh Shale Formation particularly in the presence of diversified algal forms.

Knoll (1982) reported abundant microbiota from an intraformational "flake" conglomerate within the Late Precambrian (700-800 Ma) Draken Conglomerate of NY Friesland, Spitsbergen. The microfossils were reported from silicified shards and silicified clasts of non-stromatolitic mud. It comprises mainly of mat dweller, mud benthos and planktonic algae. The Ganurgarh Shale is comparatively deficient in algal members; moreover, Acritarch are absent in Draken Conglomerate. The organic-walled microfossils of the Hunnberg Formation (750-800 Ma) of Nordaustlandet, Svalbard reported by Knoll (1984) comprised both lagoonal and open coastal facies biota. The lagoonal facies biota is dominated by algae, *Myxococcoides and Glenbotrydion* associated with few Acritarch, while the open coastal facies show common presence of Acritarch. The Ganurgarh assemblage in contrast is dominated by large sized Acritarch belonging to Sphaeromorphida. The recent report of the latest Proterozoic plankton from the Pertataka Formation, Amadeus Basin in Central Australia by Zang and Walter (1989) has two distinct type of assemblages. The lower one contains typical example of Acritarch assemblage of unornamented sphaeroidal forms and does not include any spinose Acritarch. The Ganurgarh Shale assemblage resembles to it in overall composition but differs due to the presence of ? Vendotaenid. However, it differs considerably from the Upper Pertataka assemblage in the absence of large and lavishly ornamented Acritarch.

The Sergeevskaya microfossil assemblage from Urals comprises mainly of Acritarch including structurally complex forms and to a lesser degree filamentous algae (Jankauskas, 1990). The assemblage contains *Leiosphaeridia (= Kildinella), Nucellosphaeridium, Pterospermopsimorpha* and filamentous form *Arctacellularia, Tortunema, Polythrichoides, Eomycetopsis, Ostania, Glenobotrydion (?)* and *Cholorogloeaopsis*. The Ganurgarh assemblage is comparatively poorer in the presence of tubular forms.

The Assemblage III, Upper Redkino in the boreholes of Zimnie Gorey in the Valdai Series, north western Arkhangelesk District by Ragozina and Sivertseva (1990) shows approximity to Ganurgarh assemblage as it is dominated by large forms of *Leiosphaeridia, Trachysphaerium* and *Stictosphaeridium* in association of *Orygmatosphaeridium, Nucellosphaeridium, Gloeocapsamorpha, Eomycetopsis (Leiothrichoides)* and *Polythrichoides.*

Recently, Zang (1992) reported a diversified assemblage from the Sinian of Yangtze Gorges and eastern Yunnan of South China. While describing this assemblage, he has ascertained that the Proterozoic-Cambrian transition is dominated by *Leiosphaerdia* and sphaeromorph acritarch and Lower Cambrian by spinose acritarch. The Ganurgarh assemblage seems to be older as sphaeromorph acritarch are not common.

REFERENCES

Damassa, S.P. and Knoll, A.H. 1986. Micropalaeontology of the Late Proterozoic Arcoona Quartzite Member of Tent Hill Formation, Stuart Shelf, South Australia. *Alcheringa*,**10**: 417-430.

Germs, G.J.B., Knoll, A.H. and Vidal, G. 1986. Latest Proterozoic microfossils from the Nama Group, Namibia (Southwest Africa). *Precambrian Res.***32:** 45-62.

Gnilovoskya, M.B. 1990. Vendotaenids-Vendian Metaphyte. In eds. Sokolov, B.S. & Iwanoski, A.B. Vendian System. Pt.1, *Palaeontology*,: 138-147.

Fensome, R.A., Willams, G.L., Barss, M.S. Freeman, J.M. and Hill, J.M. 1990. Acritarchs and fossil Parasinophytes an index to genera, species and infraspecific taxa. *AASP Contrb. Ser.*, **25:** 1-771.

Hermann, T.N. 1974. Findings of mass accumulation of trichomes in Riphean, *In* Timofeev, B.V.(ed) Proterozoic and Palaeozoic microfossils of the USSR, Nauka, Moscow, 6-10. (In Russian).

Jankauscus, T.V. 1990. Plant microfossils of the Urals. In eds. Sokolov B.S.& Iwanoski, A.B. Vendian System, Pt. 1, *Palaeontology*,: 171-173.

Knoll, A.H. 1982. Microfossils from the Late Precambrian Draken Conglomerate, N.Y. Friesland, Svalbard. *Jour. Palaeont.*, **56:** 755-790.

Knoll, A.H. 1984. Microbiota of the Late Precambrian Hunnberg Formation, Nordaustlandet, Svalbard.*Jour. Palaeont.*, **58** (1): 131-162.

Korkutis, V. 1981. Late Precambrian and Early Cambrian in the East European Platform. *Precambrian Res.*, **15:** 75-94.

Maithy, P.K., 1975. Microorganisms from the Bushimay System (Late Precambrian) of Kanshi Zaire. *Palaeobotanist*, **22:**(2): 133-149.

Maithy, P.K. Babu, R., Raina, G. and Kumar, G. 1988. Proterozoic microfossils from the Machhal and Lolab formations of the Kashmir Himalaya, India. *N. Jb. Geol. Palaeont. Mh.*,**10:** 637- 644.

Maithy, P.K. and Gupta, S. 1983. Microbiota and organosedimentary structures from Vindhyan Supergroup around Chandrehi, Madhya Pradesh. *Palaeobotanist*, **31:** (2) :154-164.

Maithy, PK. and Mandal, J. 1982. Significance of algal remains from the Bhanders of Vindhyan Supergroup, Rajasthan, *In* Evolutionary Botany and Biostratigraphy, Ghosh, A.K. Common. Vol.: 245-250.

Maithy, P.K. and Mandal, J. 1983. Microbiota from Vindhyan Supergroup of the Karauli-Sapotra region of Northeast Rajasthan, India. *Palaeobotanist.* **31**(2): 129-142.

Maithy, P.K. and Meena, K.L. 1989. Organic microfossils from the Late Proterozoic succession of Vindhyan Supergroup exposed around Satna and Maihar Madhya Pradesh (India). *Indian Jour. Earth Sci.*.**16** (4): 178-188.

Maithy, P.K. and Shukla, M. 1977. Microbiota from the Suket Shales, Ramapura, Vindhyan System (Late Precambrian) Madhya Pradesh. *Palaeobotanist*, **23** (3) : 176-188.

Mallet, F.R. 1869. On the Vindhyan Series as exhibted in Northwest and Central provinces of India. *Mem. Geol. Surv. India*, **7** (1): 1-203.

Naumova, S.N. 1960. Spore-complexes of the Rhipean and Cambrian. USSR *Intern. Geol. Cong.*, **21:** 109-117.

Pascoe, E.H. 1969. A manual of Geology of India and Burma, Calcutta.

Ragozina, A.L. and Sivertseva, I.A. 1990. Microfossils of the Valdai Series in the Northwestern Arkhangelsk District. *In* eds. Sokolov, B.S. and Iwanoski, A. Vendian System. Pt.1, *Palaeontology,*: 165-168.

Roy, A.K., Sharma, R.P., Sen, T.K. and Bhattacharya, A. 1981. Photogeological mapping in the elucidation of the structure and stratigraphy of a part of the Vindhyans of Central India—A case of study of Bhopal-Itarsi area and part of Narbada Valley, Madhya Pradesh. *Geol. Surv. India. Misc. Publ.*, **50:** 49-61.

Salujha, S.K., Rehman, K. and Rawat, M.S. 1971. Fossil palynomorphs from the Vindhyans of Rajasthan (India). *Rev. Palaeobot. Palynol.*,**11:** 65-83.

Song. X. Lu. G. and Xing, Y. 1984. Characteristics of the Dengyingxia an, Meishucunian and Qlongzhusian microfloras. In eds. Lou H. *et al.* Sinian-Cambrian boundary stratotype section at Meishucun, Jinning, China, : 112-115.

Srivastava, A.P. and Rajagopalan, G. 1988. F-T age of Rawatbhata area. *Jour. Geol. Soc. India* **32** : 527-529.

Srivastava, A.P. and Rajagopalan, G.1989. Glaucomy age of Vindhyan sediments in Rajasthan. Proc. 6th National Seminar on SSNTDS (ed. T.D. Goswami) Gauhati University.

Timofeev. B.V. 1958.Uber das Alter Sachsicher Grauwacken *Z. Geol.*, **7**: 3-6.

Timofeev. B.V. 1966. Microphytological investigation of ancient formations. Acad. Sci. USSR Laboratory. *Precambrian Geol. Geochronol. Leningrad, Nauka.* : 145 (In Russian).

Timofeev, B.V. 1969. Sphaeromorphida du Proterozoiques. *Eitions d Etat des Sciences (Nauka)* Leningrad, : 1-46 (In Russian).

Vidal, G. 1981a. Micropalaeontology and biostratigraphy of Upper Proterozoic and Lower Cambrian sequence in East Finmark, northern Norway. *Norges Geologiske Undrsokelse Bull.*, **362 : 1**-53.

Volkova, N.A. 1969. Acritarch of the northwest Russian Platform. Eds., Yu Razanov *et al.* Tommotian stage and the Cambrian Lower Boundary Problem. *Trans Acad. Sci. SSSR.* **206**: 234-236 (In Russian).

Zang, W.L. 1992. Sinian and early Cambrian floras and biostratigraphy on the south China platform. *Palaeontographica (B)* **224**(4-6): 75-119.

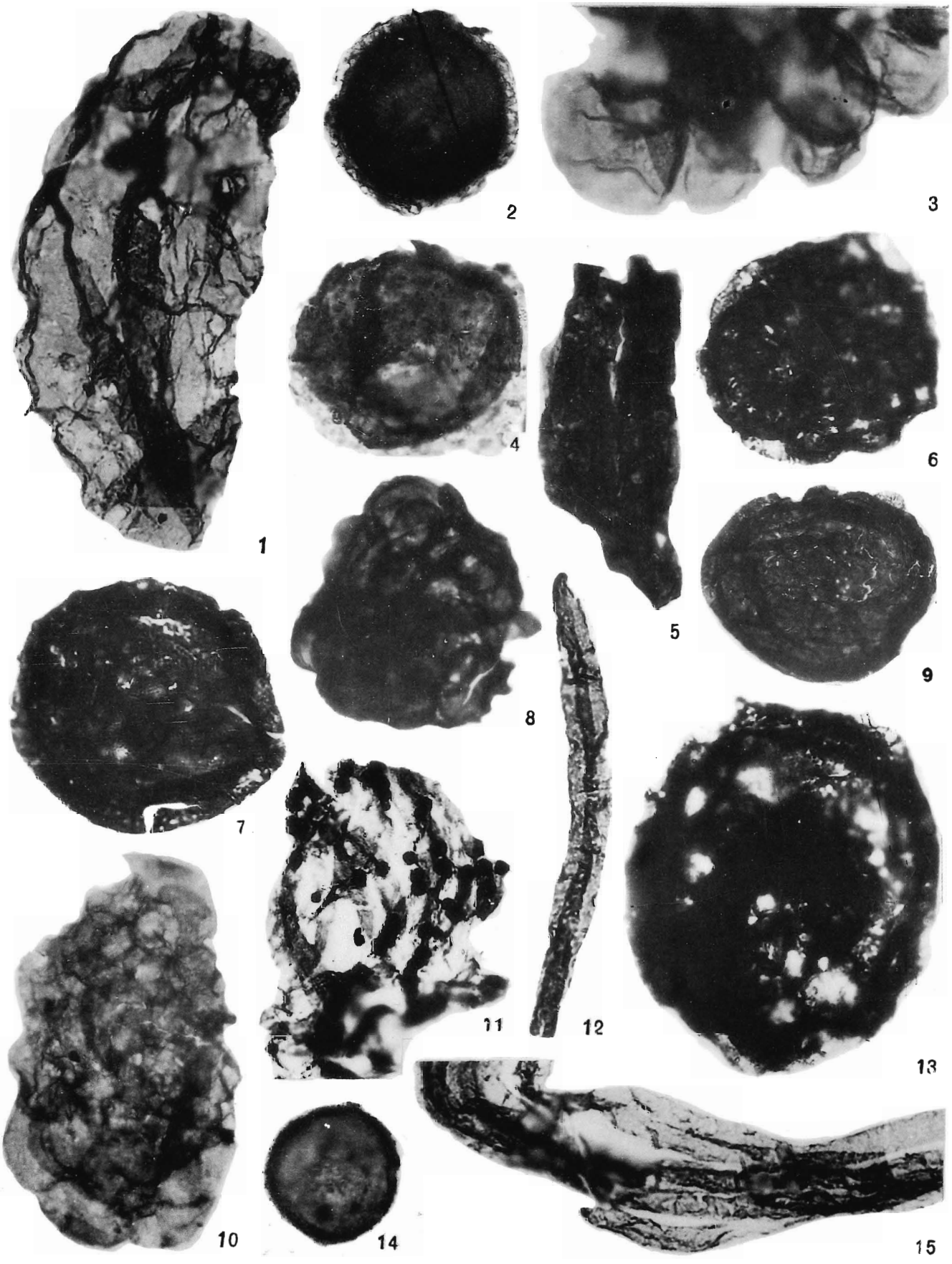
Zang, W.L. and Walter, M.R. 1989. Latest Proterozoic plankton from the Amadeous in Central Australia. *Nature*, **337** (6208): 642-645.

EXPLANATION OF PLATE

(All the photographs are x 1000 unless otherwise stated. All figured slides are preserved at the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow).

Plate -I

1. *Leiosphaeridia kanshiensis* Maithy; B.S.I.P. Slide no. 10756.
2. *Cymatiosphaeroides kullingii Knoll*; B.S.I.P. Slide no. 10751.
3. *Protosphaeridium conglutianatum* Salujha *et al.*; B.S.I.P. Slide no. 10761.
4. *Leiosphaeridia kanshiensis* Maithy; B.S.I.P. no. 10755.
5. *Multicellular* sheath; B.S.I.P. Slide no. 10761; x 500.
6. *Symplassosphaeridium bushimayensis* Maithy; B.S.I.P. Slide no. 10757.
7. *Vavosophaeridium bharadwajii* Salujha *et al.*; B.S.I.P. Slide no. 10761; x 500.
8. *Gloeocapsamorpha karauliensis* Maithy et al.; B.S.I.P. Slide no. 10759; x 500.
9. *Orygmatosphaeridium vulgarum* Maithy; B.S.I.P. Slide no. 10755; x 200.
10. *Palaeoanacystis verrucosus* Maithy et al., B.S.I.P. Slide no. 10752.
11. *Eomycetopsis rugosa* Maithy; B.S.I.P. Slide no.10759.
12. *Tubulosa corrugata* Hermann ; B.S.I.P. Slide no.10757.
13. *Nucellosphaeridium triangulatum* Maithy ;B.S.I.P. Slide no.10759.
14. *Granomarginata prima* Naumova ; B.S.I.P. Slide no.10758.
15. *Polythricoides lineatus* Jankauskas; B.S.I.P. Slide no.10757.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15