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# LATE PALAEOPROTEROZOIC (STATHERIAN) CARBONACEOUS FILMS FROM THE OLIVE SHALE (KOLDAHA SHALE), SEMRI GROUP, VINDHYAN SUPERGROUP, INDIA

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## ABSTRACT

The Olive Shale (Koldaha Shale) belonging to the Semri Group exposed in the Newari area of the Sonbhadra district, Uttar Pradesh, has yielded a variety of (macroscopic) millimetric, carbonaceous films. These films can be attributed to multicellular/thalloid macroalgae that are divided into four morphogenera and five morphospecies viz. *Changchengia stipitata* Yan, 1997, *Tuanshanzia lanceolata* Yan, 1995, *Tuanshanzia platyphylla* Yan 1997, *Leiosphaeridia* sp. and *Eopalmaria prinstina* Yan, 1995. It may represent the oldest megascopic carbonaceous remains from India and may belong to the select band of oldest carbonaceous macroscopic fossil assemblage found in Knob Lake Group, Canada; Michigamme Shales and Negaunee Formation, Michigan, USA and Changcheng Group (Changzhougou, Chauanlinggou and Tuanshanzi Formation) of Jixian, north China.

**Keywords:** Carbonaceous Films, Olive Shale, Semri Group, India, Palaeoproterozoic

## INTRODUCTION

The occurrence of macroscopic carbonaceous compressions in the Palaeo-Mesoproterozic sediments holds important clue for understanding the atmospheric oxygen concentration, evolution of obligately photosynthetic eukaryotes (such as red and green algae) and ability for nitrogen fixation. The indirect evidence for the presence of eukaryotes in Archaean and Palaeoproterozoic comes from steranes in 2700 Ma shales just south of North Pole in NW Australia and 1700 Ma bitumen of the McArthur Group, Northern Australia (Brocks *et al.*, 1999; Summons and Walter, 1990). Steranes are membrane components produced principally by eukaryotes from sterols (Ourisson *et al.*, 1987).

The discovery of a large population of *Grypania*, millimeteric coiled macroscopic compression, in 1900 Ma Negaunee Iron Formation (Han and Runnegar, 1998; Schneider *et al.*, 2002), microscopic carbonaceous fossils from the Changzhaugou Formation (1848 Ma), China (Yan, 1995; Zhang, 1997; Zhu *et al.*, 2000), carbonaceous megafossils from Chuanglinggou Formation (1800 Ma) near Jixian, China (Hofmann and Chen, 1981), macroscopic algae from 1700 Ma Tuanshanzi Formation, China (Yan, 1995; Yan and Liu, 1997), have renewed the interest in the search of antiquity of eukaryotes in Palaeoproterozoic rocks. Earlier elliptical and circular carbonaceous forms were reported from USA and Canada (Tyler *et al.*, 1957; Stinchcomb *et al.*, 1965). Besides these late Palaeoproterozoic carbonaceous remains, similar

**Table 1: Generalized lithostratigraphic succession of the Semri and the Kaimur Groups of the Vindhyan Supergroup exposed in Sonbhadra district (modified after Auden, 1933 and Bhattacharyya, 1996).**

| | | After Auden, 1933 | After Bhattacharyya, 1996 |
|---|---|---|---|
| VINDHYAN SUPERGROUP | KAIMUR GROUP | Dhandraul Quartzite | Dhandraul Sandstone |
| | | Scarp Sandstone and Shale | Mangesar Formation |
| | | Bijaigarh Shale | Bijaigarh Shale |
| | | Upper Quartzite and Sandstone | Ghaghar Sandstone |
| | | Susnai Breccia | Susnai Breccia |
| | | Lower Quartzite and Shale | Sasaram Formation |
| | | ----------UNCONFORMITY---------- | |
| | SEMRI GROUP | Nodular Limestone and Shale | Bhagwar Shale |
| | | Banded Shale and Limestone | |
| | | Nodular Limestone | Rohtasgarh Limestone |
| | | Glauconite Beds | Rampur Formation |
| | | Fawn Limestone | Salkhan Limestone |
| | | Olive Shale | Koldaha Shale |
| | | Porcellanite | Deonar Formation |
| | | Kajrahat Limestone | Kajrahat Limestone |
| | | | Arangi Formation |
| | | Basal Conglomerate | Deoland Formation |

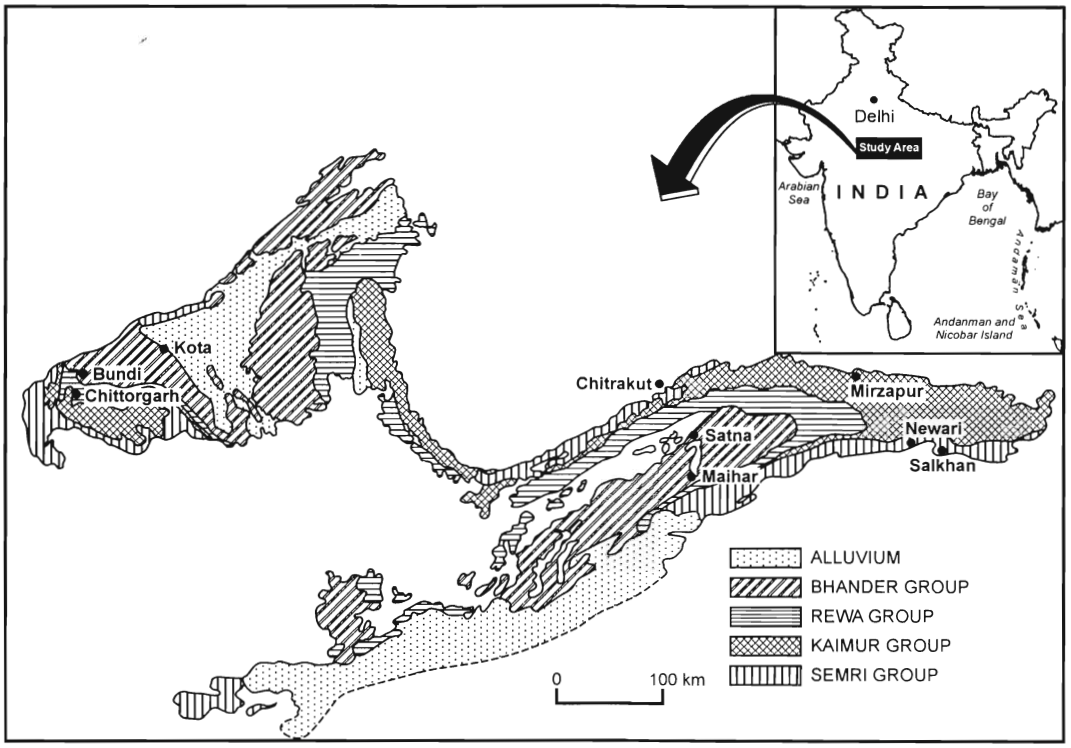


Fig. 1. Geological map of the Vindhyan Basin (after Krishnan and Swaminath, (1959).

megascopic fossils are widely recorded from Mesoproterozic sediments (Kumar, 1995; Javaux *et al.*, 2001; Walter *et al.*, 1976; Walter *et al.*, 1990).

The Vindhyan Supergroup has also revealed the presence of carbonaceous megafossils from different horizons (Jones 1909; Misra and Bhatnagar, 1950; Maithy and Shukla, 1984; Kumar, 1995, 2001; Kumar and Srivastava, 1997, 2003; Rai *et al.*, 1997; Srivastava, 2004, 2005). So far the oldest horizon which has yielded the carbonaceous megafossils is the Suket shales and its equivalent sediments of the Semri Group exposed in the Central India. In the present paper, the carbonaceous macroscopic fossils are reported from the Olive Shale of the Semri Group exposed in the Newari area, Sonbhadra district, Uttar Pradesh. Their significance is also discussed.

## GEOLOGICAL SETTING

The Vindhyan Supergroup is well exposed in Central India (Fig-1). Sediments of the basin are unmetamorphosed and tectonically little disturbed. This supergroup unconformably overlies the Bundelkhand massif and the slightly metamorphosed Bijawar Group (~2500 Ma; Crawford and Compston, 1970; Mondal *et al.*, 2002). The Vindhyan sediments comprise a thick pile of sandstone, porcellanite, shales and limestone. The rocks of the Vindhyan Supergroup are divided into four groups, namely the Semri, the Kaimur, the Rewa and the Bhander, in ascending order. The Semri Group is traditionally designated as the Lower Vindhyan whereas the Kaimur, the Rewa and the Bhander Groups are referred to as Upper Vindhyans. Each group is further divided into formations and members. Following Auden (1933) and Bhattacharyya (1996) the generalized lithostratigraphic succession of the Vindhyan Supergroup exposed in the Sonbhadra district is given in Table-1.

The Olive Shale which has yielded the megascopic carbonaceous fossils is constituted of siltstone, pelletiferus limestone, shale and sandstone. It has been noted in the entire Son Valley, with the best exposure in the Newari area (Fig. 2). The shales are about 5 meters thick showing faulted contact (Auden, 1933). The lower part is represented by greenish blue friable shale and upper part is made up of olive green compact shales. These are intercalated with yellowish grey sandstone. The Olive Shales are overlain by the Fawn Limestone. The carbonaceous megascopic remains are noted in the lower part of the Olive Shales. On the basis of sedimentary structures, the depositional environment of Olive Shale has been suggested to be lagoon to tidal flat (Singh, 1973; Banerjee, 1974; Kumar, 1978, Gupta *et al.*, 2003).

Earlier, on the basis of the glauconite dating by the K-Ar method (Vinogradov and Tugarinov, 1964) the Semri Group was considered to be of Mesoproterozoic age. The Majhgawan Kimberlite pipes intruding the Kaimur Group have been dated by Rb/Sr method as 1140 ± 12 Ma (Crawford and Compston, 1970). Recent dating of Lower Vindhyan based on Rb/Sr and SHRIMP method are summarized in Table-2. The Olive shales (Koldaha Shale) immediately overlie the Deonar Formation which has been dated by U/Pb method to be 1628 ± 8 Ma by Rasmussen *et al.* (2002) and 1631 ± 1 Ma, 1631 ± 5 Ma by Ray *et al.* (2002). The overlying Rampur Shales are dated 1599 ± 8 Ma by Rasmussen *et al.* (2002). Ray (2006) has suggested that the sedimentation of the Vindhyan Supergroup in Son Valley started sometime prior to 1721 Ma and continued until about 1600 Ma without any major break. On the basis of recent data, the age of the carbonaceous films bearing Olive Shale should be Late Palaeoproterozoic.

## METHOD AND REPOSITORY

The Olive Shale samples collected in the field were split open in the laboratory and studied using reflected light under

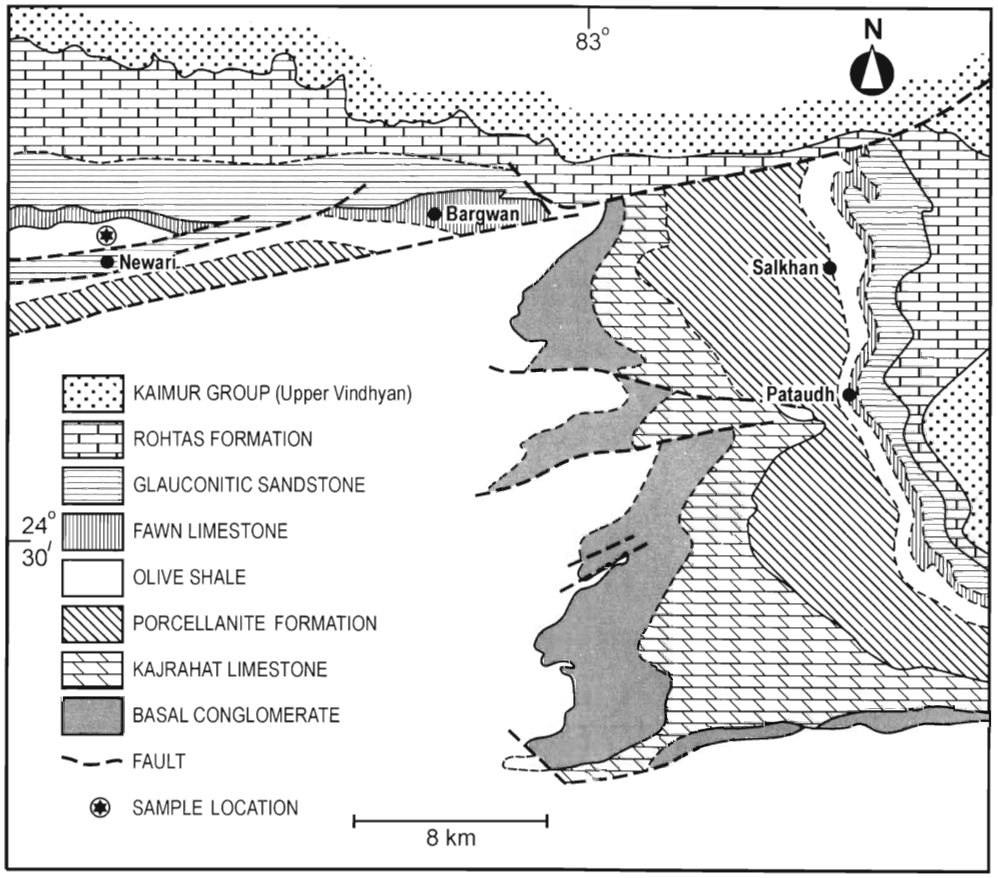


Fig. 2. Regional geological map depicting stratigraphic units in the Newari area (after Auden, 1933).

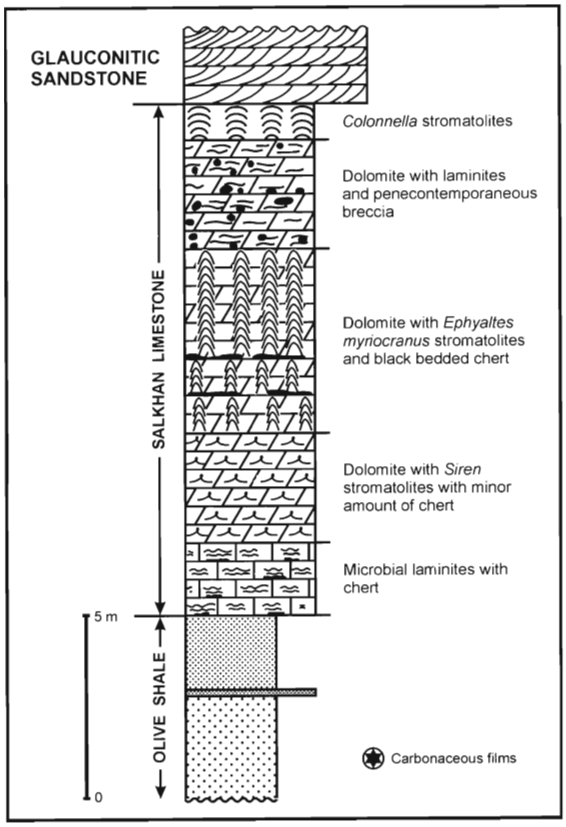


Fig. 3. Lithological column showing stratigraphic units in the Newari area (modified after Kumar and Srivastava, 1995).

a Wild Heerbrugg Microscope. Dimensions were obtained by direct measurement. Specimens were photographed on same microscope. All the specimens have been deposited in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow, bearing specimens number BSIP-39264 to BSIP-39271.

## PALAEOPROTEROZOIC CARBONACEOUS FILMS

The oldest record of the carbonaceous megascopic films is from the shaly siltstone of the Chuanlinggou Formation (1910-1800 Ma old) and from the Tuanshanzi Formation (1800-1700 Ma old), both are part of the Changcheng Group, exposed in the Yanshan Range north of Jixian, China. Hofmann and Chen (1981) presented the first palaeontological record and described *Tyrasotaenia* sp., cf. *T. podolica*, *Chuaria* sp. Zhang (1986) reported a well-preserved acritarch assemblage from the same horizons. It includes leiosphaerid acritarchs along with filamentous and disc-shaped compressions. Later, Yan (1995) and Yan and Liu (1997) described a new assemblage from the Tuanshanzi Formation comprising macroscopic algae. They reported *Changchengia stipitata, Tuanshanzia fasciaria, T. lanceolata, T. platyphylla, Eopalmaria prinstina, Proterotaenia* aff. *montana*. Distinct, spirally coiled, megascopic, carbonaceous fossils are reported from the Negaunee Formation (1900 Ma old) at the Empire Mine, near Marquette, Michigan (Han and Runnegar, 1992) and also from North America (see Hofmann, 1971).

Yan (1995), Zhang (1997) and Zhu *et al.*, (2000) reported abundant carbonaceous microfossils from the Changzhougou Formation (1848 Ma old), the lowermost unit of the Changcheng

**Table 2: Recent radiometric dates of different horizons of the Lower Vindhyan.**

| Formation | Geographical Position | Method | Age | Reference |
|---|---|---|---|---|
| Rohtas Limestone | Tikaria, Katni, M.P. | Pb-Pb, isochron | 1599 ± 48 Ma | Sarangi *et al.* 2004 |
| Rohtas Limestone | Different localities in Son Valley, M.P. & Rajasthan | Pb-Pb, isochron | 1601 ± 130 Ma | Ray *et al.* 2003 |
| Rampur Shale | Sidhi District, M.P. | SHRIMP,U-Pb, Zircon | 1599 ± 8 Ma | Rasmussen *et al.* 2002 |
| Rampur Shale (Tuff Bands) | Sidhi District, M.P. | SHRIMP, U-Pb, Zircon | 1602 ± 10 Ma<br>1628 ± 12 Ma | Rasmussen *et al.* 2002 |
| Deonar Formation (Two rhyolitic volcanic horizons) | Sidhi District, M.P. | U-Pb, Zircon, $^{87}Sr/^{86}Sr$ Isotope | 1631 ± 1 Ma<br>1631 ± 5 Ma | Ray *et al.* 2002 |
| Deonar Formation (Porcellanite Formation) | Sidhi District, M.P. | SHRIMP, U-Pb, Zircon | 1628 ± 8 Ma | Rasmussen *et al.* 2002 |
| Base of Semri Group | Chitrakoot area, U.P. | Rb-Sr Model ages | 1409 ± 14 Ma to 1531 ± 15 Ma | Kumar *et al.* 2001 |
| Basement Rocks | Bundelkhand Granite | Pb-Pb Zircon (SIMS) | 2492 ± 10 Ma | Mondal *et al* 2002 |

Group. The Changzhougou assemblage is dominated by sphaeromorph acritarch that can be referred to *Leiosphaeridia, Chuaria, Shousienia* (Ellpsophyta) and *Tawuia*.

## NEWARI CARBONACEOUS MACROFOSSILS

The megascopic remains reported here were found in the Olive Shale exposed in the Newari area of the Sonbhadra district, U.P., at the Newari-Chitikpurwa border Nala (Fig. 3). All the Olive Shale carbonaceous macroscopic films are within the shale and are compressed parallel to bedding. The shale layers are rich in millimetric to submillimetric, angulate to rounded, filamentous to scraps of carbonaceous films. Some of them are similar to problematic taxa such as *Beltina danai* Walcott (1899) and *Morania ? antiqua* Fenton and Fenton (1937). In the scraps and debris of carbonized organic matter, the taxonomically identifiable forms are rare. In this assemblage occur specimens of *Changchengia stipitata, Tuanshanzia lanceolata, Tuanshanzia platyphylla, Leiospheridia* sp., *Eopalmaria prinstina* which are subject of the present paper.

*Changchengia stipitata* Yan 1997 in Yan and Liu, 1997
(Pl. I, figs. 3-5)

*Synonymy*: *Tuanshanzia stipitata* Yan, 1995, p. 124, pl. I, figs. 3, 5 A, 6, 10; pl. II, fig. 18.- Yan and Liu, 1997, p. 37, pl. II, figs. 1-15.

*Specimen no.*: BSIP-39266, 39268.

*Stratigraphic position*: Olive Shale, Semri Group, Vindhyan Supergroup.

*Locality*: Newari area, Sonbhadra district, Uttar Pradesh.

*Lithology*: Olive coloured shale.

*Description*: Broad ribbon-like, lanceolate forms, tapering towards base and apex, margins of the ribbon are smooth, sometime flapped in the middle, surface of the blades even, no longitudinal striae are seen. The average length to width ratio is equal to 6, the width is 1-3 mm and length is 6-20 mm.

*Remarks*: The tapering lower part of the fossil may be a short parastem or poorly preserved anchoring organ suggesting it to be primitive benthic multicellular algae. Such algal growth could occur in quite lagoonal environment. Flapped portions

## EXPLANATION OF PLATE I

(Scale bar in figures 1, 2, 3, 10, 12, 18 = 1mm; figures 4, 5, 6, 9 =2 mm, figures 8, 13, 14, 15, 16, 17 = 0.5 mm; figure 11=1.5 mm).

1. ***Tuanshanzia lanceolata*** (Specimen number BSIP-39268).
2. ***Tuanshanzia lanceolata*** (Specimen number BSIP-39266).
3. ***Changchengia stipitata*** (Specimen number BSIP-39266).
4. ***Changchengia stipitata*** (Specimen number BSIP-39266).
5. ***Changchengia stipitata*** (Specimen number BSIP-39268).
6. ***Eopalmaria prinstina*** (Specimen number BSIP-39271).
7. ***Tuanshanzia platyphylla*** (Specimen numbers BSIP-39271).
8. ***Tuanshanzia lanceolata*** (Specimen number BSIP-39264).
9. ***Tuanshanzia lanceolata*** (Specimen number BSIP-39264).
10. ***Tuanshanzia platyphylla*** (Specimen numbers BSIP-39267).
11. ***Eopalmaria prinstina*** (Specimen number BSIP-39266).
12. ***Leiosphaeridia*** (Specimen number BSIP-39264).
13. ***Tuanshanzia platyphylla*** (Specimen numbers BSIP-39269).
14. ***Eopalmaria prinstina*** (Specimen number BSIP-39265).
15. ***Tuanshanzia platyphylla*** (Specimen numbers BSIP-39270).
16. ***Tuanshanzia platyphylla*** (Specimen numbers BSIP-39269).
17. ***Eopalmaria prinstina*** (Specimen number BSIP-39264).
18. ***Eopalmaria prinstina*** (Specimen numbers BSIP-39266).

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**Plate I**

in the middle may be broken parts due to occasional current movement in the otherwise stagnant water body. The *Changchengia stipitata* can be differentiated from the *Lanceoforma striata* by large size and absence of striations on the surface of the blades.

*Tuanshanzia lanceolata* Yan, 1995
(Pl. I, figs. 1, 2, 8, 9)

*Synonmy*: *Tuanshanzia lanceolata* Yan, 1995, p. 123-124, pl. II, figs. 4-8, Yan and Liu, 1997, p. 38, pl. IV, figs. 1-10.

*Specimen no.*: BSIP-29268, 39266, 39264.

*Stratigraphic position*: Olive Shale, Semri Group, Vindhyan Supergroup.

*Locality*: Newari area, Sonbhadra district, Uttar Pradesh.

*Lithology*: Olive coloured shale.

*Description*: Broad sheet-like thalli, sometimes lanceolate, narrowing towards one end, widest in the middle, margins even, no foldings seen, without parastem in one specimens (Pl. I, fig. 1) a cuneiform protuberance seen. 4 to 5 mm in length and 0.5 to 1 mm in width average width to length ratio is 8-5.

*Remarks*: Flat sheet-like compression resembles the tubular thalli of some of the Phaeophyta or Chlorophyta. It is distinguished from *T. platyphylla* by larger size and length-width ratio. It can be differentiated from *Lanceoforma striata* Walter *et al.* by sheet-like thalli and occasional lanceolate shape. No striations are noticed. Size is smaller in comparison to the *Changchengia stipitata* and *Lanceoforma striata*.

*Tuanshanzia platyphylla* Yan, 1995
(Pl. I, figs. 7, 10, 13, 15, 16)

*Synonymy*: *Tuanshanzia platyphylla* Yan, 1995, p. 124, pl. II, figs. 9-12; Yan, 1997 in Yan and Liu, 1997, p. 38-39, pl. IV, figs. 11-17, 20, 21.

*Specimen no.*: BSIP-39271, 39267, 39269, 39270.

*Stratigraphic position*: Olive Shale, Semri Group, Vindhyan Supergroup.

*Locality*: Newari area, Sonbhadra district, Uttar Pradesh.

*Lithology*: Olive colured shale.

*Description*: Thalli oval, with rounded to rotundate apex and pointed base, pointed base appears as a stalk-like projection, millimetric to submillimetric in size 0.5 mm to 3 mm in length and 0.25 mm to 1mm in width.

*Remarks*: The present species differs from *T. lanceolata* in thalli morphology i.e. platyphyllous blades and in length to width ratio. The small thalli of *T. platyphylla* may be a variant of *T. lanceolata* in the life cycle of algal population. Stalk-like projection is akin to parastem suggesting the specimen to be sessile thallus.

*Leiosphaeridia*
(Pl. I, fig. 12)

*Synonymy*: See Butterfield *et al.* 1994.

*Specimen no.*: BSIP-39264.

*Stratigraphic position*: Olive Shale, Semri Group, Vindhyan Supergroup.

*Locality*: Newari area, Sonbhadra district, Uttar Pradesh.

*Lithology*: Olive coloured shale.

*Description*: Finely textured leiospheres, 0.5 to 1.0 mm in diameter, wall thin, translucent, when present folds in different directions.

*Remarks*: Jankauskas *et al.* (1987, 1989) and Butterfield *et al.*, (1994) revised the Proterozoic leiosphaerid acritarchs. Based on wall thickness and size smooth walled forms are grouped into four species. Further larger specimens are put into *Leiosphaeridia wimanii*. In this group some of the specimens akin to *Chuaria* are also included. Olive Shale members are slightly smaller and leave only slightest, if any, perceptible imprint on bedding-plane surface, are not psilate or finely textured, no medial-split- release structures are noticed and therefore categorized as *Leiosphaeridia* sp.

*Eopalmaria prinstina* Yan 1995
(Pl. I, figs. 6, 11, 14, 17, 18)

*Synonymy*: Yan, 1995, p. 124, pl. II, figs. 1-3; Yan and Liu, 1997, p. 38-39, pl. IV, figs. 18, 19, pl. V, figs. 1-7.

*Specimen no*: BSIP-39271, 39266, 39265, 39264.

*Stratigraphic position*: Olive Shale, Semri Group, Vindhyan Supergroup.

*Locality*: Newari area, Sonbhadra district, Uttar Pradesh.
*Lithology*: Olive coloured shale.

*Description*: Thalli sheet-like, oval to cuneiform, sometime depression on the rounded end giving forked appearance, base narrow, occasionally parastem shaped. 0.75-2 mm in length and 0.5 – 1 mm in width.

*Remarks*: This species, though smaller in size, widely occurs in the Olive Shale suggesting that they are the member of the sheet-like sessile macroscopic algae that can be compared to advanced algae of present day.

## DISCUSSION

Large assemblages of morphologically distinct carbonaceous remains are known from Palaeoproterozoic to Neoproterozoic sediments, but most of these lack distinctive characters except the gross morphology, and the biological affinities of these assemblages are still uncertain (Hofmann, 1992). Several attempts have been made for suprageneric biological classification of these carbonaceous films, but none is comprehensive and generally acceptable. Commonly

megascopic carbonaceous films are put into informal categories. Hofmann (1985, 1987) used a tentative informal system of categories for genus-level taxa after the dominant genus. Their affinities still need to be precisely determined and therefore they can be assigned to both prokaryotic and eukaryotic organisms (Hofmann, 1992). Contrary to this, biologists can easily distinguish between prokaryotes and eukaryotes, cyanobacterial colony, red, green and brown algae based on cellular organization, genetics and physiology; but these features are not available to palaeontologists and one therefore has to rely mainly on the morphoform (Knoll, 1996). Besides, taphonomy and preservation play a crucial role in differentiation and identification of carbonaceous megafossils. The same holds true for the Olive Shale assemblage.

Well-established fossils comparable to modern eukaryotes are found in the 700-750 Ma old Spitsbergen Shales (Butterfield *et al.,* 1994). Beautifully preserved fossils that can be compared with eukaryotic red algae are found in the 1200 Ma old Somerset Island in arctic Canada (Butterfield, 2000). Tyler *et al.* (1957) reported graphitic forms having circular and elliptical shape from the Huronian Michigamme Shales of the Iron River District of Michigan. Similar forms were reported by Stinchcomb *et al.,* (1965) from Labrador Trough, Quebec. Both these fossil 'like forms' have been considered as ?*Morania* by Hofmann (1992, p. 958). In these forms, there is a constancy of morphology and manner of fossilization, whereas Olive Shale forms show a large variation and diversity in morphology. All these discoveries are indicator of possibility of the occurrence of advanced eukaryotic remains in still older strata such as the Olive Shale.

Following the general practice, all the reported Late Palaeoproterozoic and Early Mesoproterozoic eukaryotic remains, thalloid forms are assigned the taxonomic status on the basis of morphological comparisons. The Olive Shale remains are preserved in the organic debris on the bedding plane. Based on their megascopic size, parastem like features, and thalloid morphology, these carbonaceous films are classified in five distinct forms which can be attributed to eukaryotic algae but it is difficult to assign them to any specific group. There is a slight difference of size, folding patter and tapering ends among the *Lanceoforma striata* described by Walter *et al.* (1976) and the specimens of the *Changchengia stipitata* and *Tuanshanzia platyphylla* described in this paper. The author tentatively views these fossils as remnants of megascopic algae with thalloid body and in some cases with parastem, but he is unaware of any definite analogue. Further biomarker studies of the Olive Shale will help in establishing the correct identity.

There is all out effort to record eukaryotic remains and thalloid forms in older strata to substantiate the biomolecular record. Of late, discoveries have shown the presence of eukaryotic organisms in Late Palaeoproterozoic as well as in Early Mesproterozoic sediments. Discovery of steranes - a biomarker, membrane stiffening compound made predominantly by eukaryotes - in the 2700 Ma old shales just south of North Pole in NW Australia, 1700 Ma old bitumen of the McArthur Group, northern Australia and Late Proterozic Walcott Member, Chuar Group, Grand Canyon, USA (Brocks *et al.,* 1999; Summons and Walter, 1990; Summons *et al.*, 1988) opened a new vista for Precambrian palaeobiologists to find out the traces of eukaryotes. Study of the biomolecules in sediments suggests their early advent in the earth's history, but actual remains are found in a billion year younger rocks. If the biomolecules of eukaryotes are detected so early in the earth history, one should certainly expect to get their remains in the rock record. Their absence for more than billion and a half years before the actual remains is intriguing. It is suggested that the ability to make sterol compounds might have originated but "complete eukaryotic cell with distinctive genes differentiated nucleus, cytoskeleton and mitrochondira evolved much later" (Knoll, 2003, p. 153).

Study of the palaeoweathering profiles (Holland and Beukes, 1990; Ohmoto, 1996; Rye and Holland, 1998) and Sulphur isotope studies (Canfield, 1998; Catling *et al.,* 2001; Kasting and Seifert 2002) suggests that a major environmental shift occurred around 2200-1900 Ma ago and at that time atmospheric oxygen concentrations first exceeded 1-2% PAL, gradually rising and accumulating to 15% PAL or more. The increase in the $pO_2$ to 15% would have increased the nitrate input into the oceans. With the availability of fixed nitrogen, it would have paved the way for the evolution of obligately photosynthetic eukaryotes such as most red and green algae (Knoll and Holland, 1995). These geochemical data need corroborating palaeontological evidences. Discovery of steranes by Brocks *et al.* (1999) in 2700 Ma old shales just south of North Pole in northwestern Australia and 1700 Ma bitumen of McArthur Group, Northern Australia (Summons and Walter, 1990) indicates that the eukaryotes appeared on the earth by this time. All these discoveries indirectly point to the rising O level in the Earth's environment. The palaeontological discoveries would also help in understanding the increase in $pO_2$ level in the atmosphere. The present report from the Olive Shale is an effort to fulfill this gap in the records.

## CONCLUSIONS

1. The Olive Shale carbonaceous films are grouped into four morphogenera and five morphospecies.
2. On the basis of their megascopic size, thalloid nature and possible parastem like features, these are attributed to eukaryotic algae.
3. The present record belongs to the select band of Palaeoproterozoic carbonaceous films of eukaryotic remains known from the Knob Lake Group, the Canada; Michigamme Shales and the Negaunee Iron Formation, Michigan USA and the Changcheng Group, China.
4. The Olive Shale carbonaceous macrofossils are at present the oldest level of carbonaceous fossils recorded from the Vindhyan Supergroup.

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