



CARBONACEOUS MEGAFOSSILS FROM THE DHOLPURA SHALE, UPPERMOST VINDHYAN SUPERGROUP, RAJASTHAN : AN AGE IMPLICATION

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ABSTRACT

Carbonaceous megafossils comprising *Chuarina-Tawuia* assemblage are reported for the first time from the Dholpura Shale, the youngest lithounit of the Vindhyan Supergroup, exposed in the Balwan area, Rajasthan. On the basis of the *Chuarina-Tawuia* assemblage (representing a biozone ranging in age from 950 to 700 Ma.), it is suggested that the upper age limit of the Vindhyan Supergroup should be within Neoproterozoic.

Key words: Carbonaceous megafossils, Dholpura Shale, Vindhyan Supergroup, Rajasthan

INTRODUCTION

The Vindhyan Supergroup has drawn global attention in recent years. Its age has become a matter of debate since the discoveries of triploblastic animal traces by Seilacher *et al.* (1998) and small shelly fauna by Azmi (1998) from the lower Vindhyan. Furthermore, Precambrian-Cambrian boundary has also been suggested within the Vindhyan by Friedman and Chakraborty (1997) and Banerjee and Frank (1999). Very recently, new radiometric dates for the Lower Vindhyan have been reported by Ray *et al.* (2002), Rasmussen *et al.* (2002) and isotope analysis has also been done in the Lower as well as the Upper Vindhyan by Kumar *et al.* (2002). All these findings are against the conventional age of the Vindhyan Supergroup, which is considered Ca ~ 1400- 600 Ma. The present note reports some megafossils which reinforce the conventional view and indicate the upper age limit of the Vindhyan.

Well-preserved carbonaceous megafossils (dominated by *Chuarina* and rare occurrence of *Tawuia*) have been found in the Dholpura Shale, the youngest horizon and the uppermost lithostratigraphic unit of the Bhandar Group, Vindhyan Supergroup, Balwan area, Rajasthan. The report of such megafossils constitutes an important finding from the uppermost lithounit of the Vindhyan Supergroup. The presence of these megafossils in the youngest part of the Vindhyan Supergroup is biostratigraphically significant in suggesting the

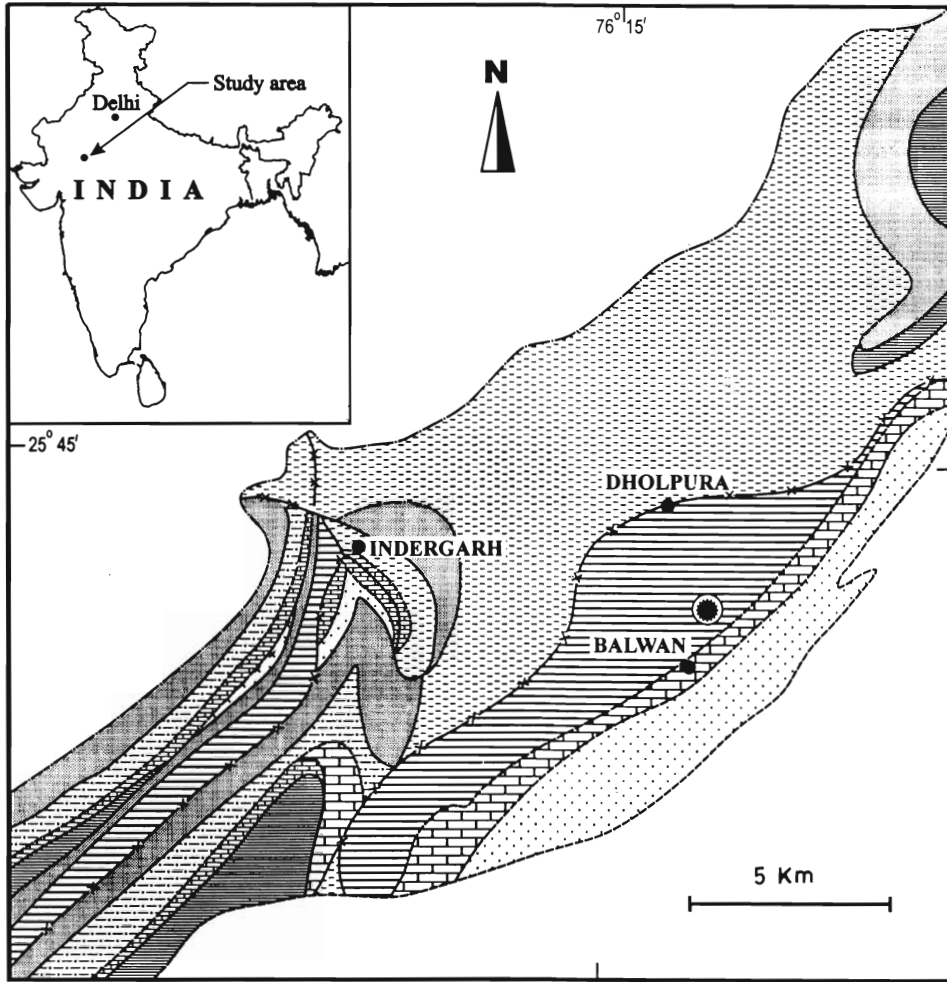
upper age limit of the Supergroup.

The Vindhyan Basin is an exceptionally large basin occupying an area of about 1,04,000 square kilometers in Central India, from Bihar to Rajasthan. The rocks of the Vindhyan Supergroup attain a maximum thickness of about 4000 meters. The Supergroup is subdivided into four groups viz. the Semri Group, the Kaimur Group, the Rewa Group and the Bhandar Group, in stratigraphic order. The Semri Group is considered as the Lower Vindhyan, whereas the other three groups constitute the Upper Vindhyan.

GEOLOGICAL SETTING

The Upper Vindhyan succession is well developed in Rajasthan, where it forms small hillocks and escarpments. The lithology is represented by limestone, shale, siltstone and sandstone.

The name 'Dholpura Shale' was suggested by Prasad (1981) for the Uppermost Bhandar shale, constituting the youngest lithostratigraphic unit of the Supergroup. The Dholpura Shale conformably overlies the Balwan Limestone (figs. 1, 2), which is stromatolitic in nature. *Baicalia* spp. is well developed in the Balwan Limestone, which has a faulted contact with the Bundi Hill Sandstone and the Sirbu Shale (Table 1) on the northeast of Lakheri in Rajasthan (Prasad, 1984). The outcrop of carbonaceous megafossil-bearing Dholpura Shale is



(After Balmiki Prasad, 1984)

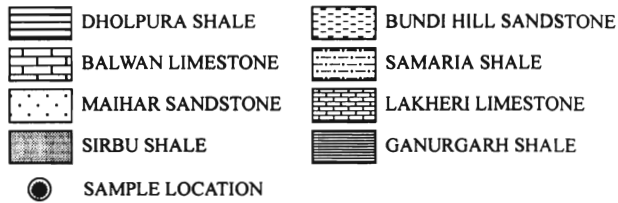


Fig. 1. Geological map of the Balwan Area, Rajasthan (after Prasad, 1984).

well exposed in Kunwarpura Bhatta locality of the Balwan area near Indergarh.

Table 1 : Lithostratigraphy of the Bhander Group (Table 1, After Prasad, 1981)

Group	Formation	Thickness In Meters
Bhander	Dholpura Shale	60
	Balwan Limestone	120
	Maihar Sandstone	130
	Sirbu Shale	170
	Bundi Hill Sandstone	250
	Samaria Shale	133
	Lakheri Limestone	150
	Ganurgarh Shale	200

The fossiliferous Dholpura Shale is olive green to greyish green in colour, splintery in nature, where intercalations of silty shale and ferruginous shale are very common. The fossil-bearing green shale overlies the unfossiliferous chocolate brown shale.

AGE OF THE VINDHYAN SUPERGROUP

The rocks of the Vindhyan Supergroup are intruded by igneous dykes at few places, which have been dated radiometrically by K/Ar, Rb/ Sr, U/ Pb and Ar/ Ar methods by Vinogradov and Tugarinov (1964), Crawford and Compston (1970), Kumar *et al.* (1993), Banerjee and Frank (1998) and Banerjee (2000).

Recently, radiometric dates obtained by Rasmussen *et al.* (2002) provided data from the lower Vindhyan by using SHRIMP U-Pb zircon geochronology, dating the tuffs bounding the Chorhat Sandstone. Their study shows that the sediments were deposited between 1628 ± 8 Ma and 1599 ± 8 Ma respectively. Ray *et al.* (2002) dated the rhyolitic volcanic horizon from the Deonar Formation between Kajrahat and Rohtasgarh Limestone and below the unit containing Seilacher's *et al.* (1998) trace fossils that yielded U-Pb zircon ages of 1631 ± 5 Ma and 1631 ± 1 Ma respectively.

The Fission Track dates are also available for the Vindhyan rocks (Srivastava and Rajagopalan, 1986, 1988; Rajagopalan and Maithy, 1993). These ages range from 1378 Ma to 710 Ma for the Rewa Group.

Friedman and Chakraborty (1997) suggested

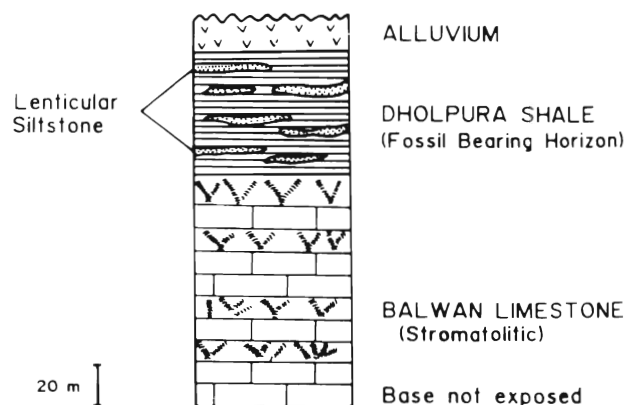


Fig. 2. Lithological column of the fossil-bearing horizon in Kunwarpura Bhatta locality, Balwan area, Rajasthan.

that the Precambrian-Cambrian Boundary can be marked in the Vindhyan Supergroup on the basis of carbon isotopic analysis of the Bhander Limestone of the Bhander Group on samples collected from Maihar-Dhanwahi Road. However, Kumar (1998) pointed out that the Precambrian-Cambrian Boundary can only be marked on the basis of biological events and their evidences. The Precambrian-Cambrian boundary stratotype was designated by international agreement (IUGS Kyoto, 1992) as the base of the *Phycodes pedum* zone in Newfoundland (Brasier *et al.* 1994). Since no Cambrian fossil has so far been reported, the Precambrian-Cambrian Boundary and the Cambrian age assigned to the top of the Vindhyan Supergroup cannot justifiably be supported. Radiometric dates available for the Vindhyan Supergroup are presented in the table 2.

Palaeontological evidences for the age assignment of the Vindhyan Supergroup are based on: microbialites, microfossils, ichnofossils and megafossils.

Microbialites

Distinctive morphologies exhibited by stromatolites such as *Kussiella*, *Conophyton* and *Colonnella* assemblages are assigned the Lower to Upper Riphean age by Auden (1933), Kumar (1982), Mathur (1987), Prasad and Ramasamy (1980) and

Table 2 : Summary of available geochronological data on different members of Semri, Kaimur and Rewa groups of the Vindhyan Supergroup (after Kumar *et al.* 2002).

Member	Age (Ma)	Method	Referene
Sandstone	710± 120	Fission Track	Srivastava & Rajagopalan (1988)
(Rewa Group)	690± 125		
Majhgawan lamproite intruded in Kaimur Sandstone	1067± 31	Rb/ Sr	Kumar <i>et al.</i> (1993)
Majhgawan Kimberlite Pipe intruded in Kaimur Group.	1140± 12	Rb/ Sr	Crawford & Compston (1970)
Rohtas Limestone (Semri Group)	1100± 60	K/ Ar	Vinogradov <i>et al.</i> (1964)
	1125± 175	Fission Track	Srivastava & Rajagopalan (1988)
	1060	K/ Ar	Tugarinov <i>et al.</i> (1965)
Deonar Formation	1631± 5	U- Pb zircon	Ray <i>et al.</i> (2002)
	1631± 1		
Chorhat Limestone (Semri Group)	1145± 40	K/Ar	Vinogradov <i>et al.</i> (1964)
	1070± 40		
	1115± 45		
	1115± 44		
Chorhat Sandstone	1628± 8	U-Pb zircon Geochronology	Rasmussen <i>et al.</i> (2002)
Fawn Limestone (Semri Group)	1110± 44	K/Ar	Vinogradov & Tugarinov (1964)
	1160± 46		
	1175± 45		
	990± 50	Fission Track	Rajagopalan & Maithy (1993)
Koldaha Shale (Semri Group)	1219± 183	Fission Track	Srivastava & Rajagopalan (1986)
	1205± 234	Fission Track	Srivastava <i>et al.</i> (1985)
Porcellanite Formation (Semri Group)	617± 3.5	Ar/Ar	Banerjee & Frank (1999)
	900- 1500	Ar/ Ar	Banerjee (2000)

Venkatachala *et al.* (1996).

Microfossils

On the basis of microfossil assemblage reported from the Sirbu Shale (Upper Vindhyan) by Kumar and Srivastava (1997a), pre-Vendian age has been suggested for the Dholpura Shale because no typical Vendian form or acanthomorph has yet been reported from any of the microfossil assemblage recorded from the uppermost Vindhyan.

A diversified microfossil assemblage dominated by benthic population of Cyanobacteria is a common feature of the Lower Vindhyan. In addition to the cyanobacterial population, presence of algal, fungal and acritarch forms has also been found in the Lower as well as the Upper Vindhyan microfossil assemblages (Srivastava and Kumar, 1997).

Ichnofossils

Burrows and bioturbation of sediments are reported by Chakraborty (1990) from the Bundi Hill Sandstone of the Bhandar Group and triploblastic

animal traces from the Chorhat Sandstone of Lower Vindhyan by Seilacher *et al.* (1998).

Megafossils

The wide ranging megascopic carbonaceous remains provide an additional parameter for age assessment. Megafossils as well as the trace fossils are considered the important biostratigraphic markers for the terminal Precambrian all over the world. Megafossils reported from the Vindhyan Supergroup tentatively suggest an age between 1000 and 600 Ma. (Venkatachala *et al.*, 1996). On the basis of biota recorded from the Supergroup, Maithy and Babu (1997) suggested Vendian as the Upper age limit for the Vindhyan Supergroup.

Megafossils have already been reported from the Lower and Upper Vindhyan (the Semri Group) by Ghare and Badve (1978), Kumar (1995), from the Jhiri Shale of the Rewa Group by Rai *et al.* (1970) and from the Sirbu Shale of the Bhandar Group by Kumar and Srivastava (1997 b). *Chuarita-Tawuia* and other morphotypes, such as ribbon-

shaped filaments and oscillatoriacean filaments are the megascopic structures reported from the Sirbu Shale. The *Chuariala-Tawuia* assemblage may be of considerable help in fixing the upper age limit for the Vindhyan Supergroup.

SYSTEMATIC PALAEOLOGY

Class **Chuariiphyceae** Gnilovskaya & Ishchenko in Gnilovskaya *et al.*, 1988

Family **Chuariaceae** Wenz, 1938 emend. Duan, 1982

Genus **Chuariala** (Walcott, 1899), emend. Vidal & Ford, 1985

(Type Species: *Chuariala circularis* (Walcott, 1899), Vidal and Ford, 1985)

Stratigraphic position: The Dholpura Shale, the Bhandar Group (Upper Vindhyan)

(Fig. 5- B, C, D, H, I, J)

Description: Circular to elliptical, brown to black coloured carbonaceous discs with well developed concentric wrinkles. Diameter varies from .5 to 4.7 mm (mean 2.5 mm, N= 34, fig. 3). At a few places these compressions occur in clusters.

Discussion: In India, *Chuariala circularis* was first reported from the Suket Shale of the Semri Group (Lower Vindhyan) in Rampura area of Madhya Pradesh by Jones (1909) then by Sahni (1977). Later on, it was described in detail from the Rohtas Formation of the Semri Group, in Katni area,

Madhya Pradesh by Kumar (1995), from the Jhiri Shale of Rewa Group by Rai *et al.* (1997) and from the Sirbu shale, Maihar area by Kumar and Srivastava (1997b). The maximum diameter for *Chuariala* specimens in Suket Shale is 4.4 mm and for Jhiri and the Sirbu Shale specimens, it is 3.7 mm and 5.1 mm respectively. For the Dholpura specimens, it is 4.7 mm. In India, *Chuariala circularis* has also been reported from the Bhima Basin where the dimensions are comparatively much larger and reach up to 10 mm (Maithy and Babu, 1996). Zang (1997) reported *Chuariala-Tawuia* assemblage from the Wilpena Group of South Australia, associated with the morphologically complex spinose acritarchs (acanthomorphs). This fossiliferous horizon is overlain by the Ediacara fauna- bearing Rawnsley Quartzite, which has extended the known time range of *Chuariala-Tawuia* assemblage to the latest Neoproterozoic.

Family **Tawuiaceae**, Ishchenko in Gnilovskaya *et al.*, 1988

Genus **Tawuia** Hofmann, in Hofmann & Aitken, 1979

(Type species: *Tawuia dalensis* Hofmann and Aitken, 1979)

(Fig. 5- E, F, G)

Description: Short, compressed, elliptical to oblong carbonaceous objects with rounded terminals and some times occurring as smooth impressions only, where the carbonaceous matter is removed. Few specimens are fragmentary. The observed

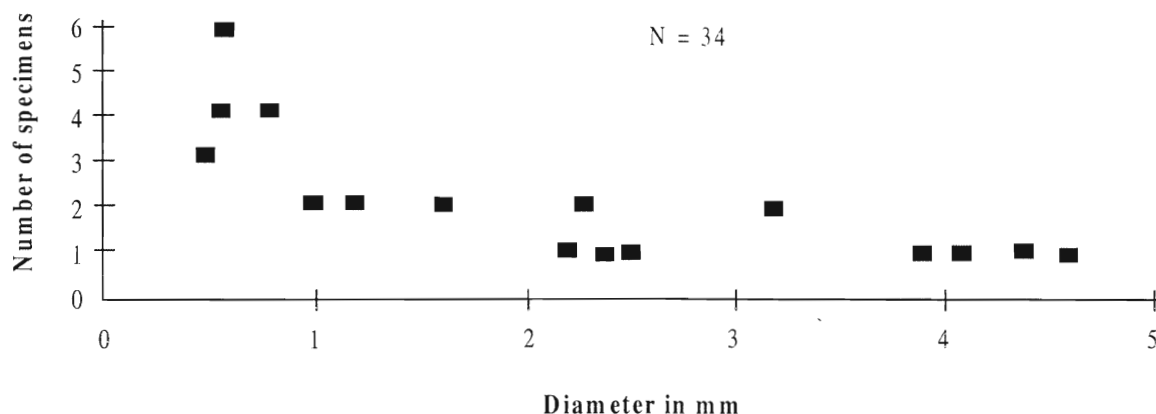


Fig. 3. Scatter diagram of diameters of *Chuariala circularis*.

dimensions vary from 0.6 to 1.8 mm (short axis) and from 1.3 to 4.2 mm (long axis), five specimens measured (Fig.4). Longitudinal and diagonal folds are also present.

Discussion : There are three other reports available for the Vindhyan Supergroup from where *Tawuia* is reported. These are the Suket Shale of the Semri Group (Lower Vindhyan), from the Jhiri Shale and from the Sirbu Shale of the Bhandar Group (Upper Vindhyan). Dimensions in the Suket Shale specimens vary from 1- 2.5 mm, whereas those from the Sirbu Shale are from .8- 1.6 mm across. The present forms exhibit comparatively wider size range in comparison to the other two assemblages of the Vindhyan Supergroup. *Tawuia* has also been reported from the Halkal Formation of the Bhima Group, where the width is between 2- 3 mm, and the length reaches up to 30 mm (Maithy and Babu, 1996). *Tawuia* always occurs in association with *Chuarua*, however *Chuarua* can also occur in isolation. Earlier described ellipsoidal forms named as *Fermoria*, *Ellipsophysa* and *Mezenia* are now considered the synonyms of *Tawuia* (Hofmann, 1985).

Chuarua-Tawuia assemblage reported from the Jhiri Shale Formation of the Rewa Group are comparatively larger in size than the Dholpura specimens. Globally, *Tawuia dalensis* has been

recorded from the Svalbard, China, Russia, Australia and West Africa.

DISCUSSION AND CONCLUSION

The presence of carbonaceous megafossils in the Dholpura Shale of the Bhandar Group, (the youngest lithostratigraphic unit of the entire Vindhyan Supergroup) is biostratigraphically significant as on the basis of their presence the upper age limit of the Vindhyan Supergroup is being suggested.

Among carbonaceous megafossils, *Chuarua* and *Tawuia* are the most common forms which generally occur together. The *Chuarua-Tawuia* assemblage was earlier considered to be a biostratigraphic marker, ranging in age from 1100 Ma. to 700 Ma (Hofmann 1985). Hofmann and Rainbird (1994) interpreted the consistency of *Chuarua-Tawuia* assemblage in Neo- proterozoic biozone by its presence in the Shaler Group of Arctic Canada. Zang (1997) extended the biostratigraphic range of these carbonaceous megafossils up to the latest Proterozoic. Amard (1997) suggested the Lower Cambrian age for *Chuarua*-bearing horizon in the Pendjari Formation of Australia on the basis of a new species *Chuarua pendjariensis*. However, age assignment on the basis of a new species is not

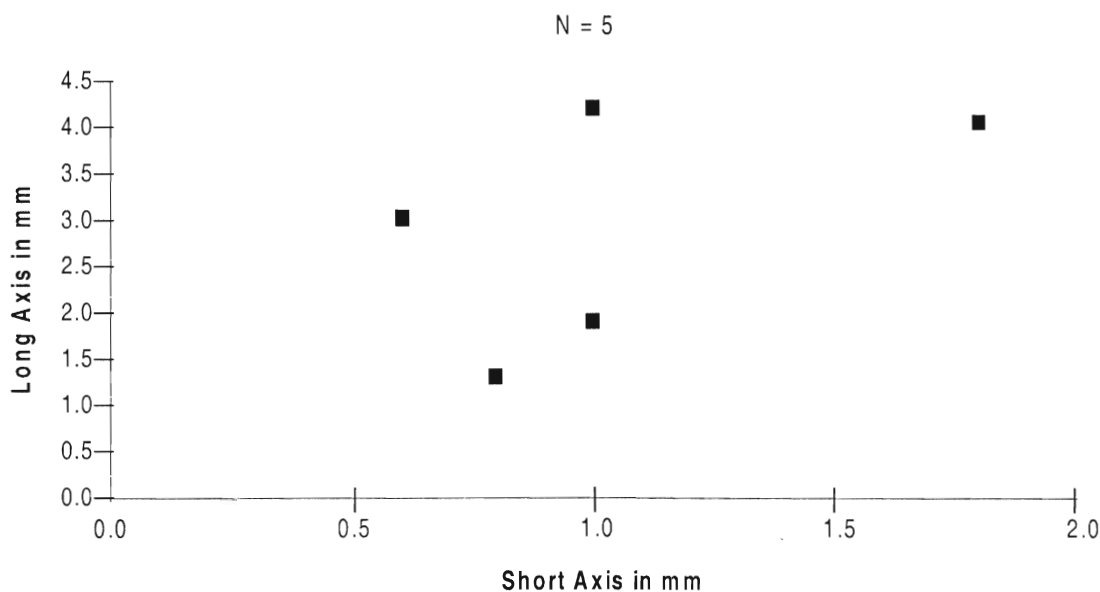


Fig. 4. Scatter Diagram of shorter and longer diameters of *Tawuia*.

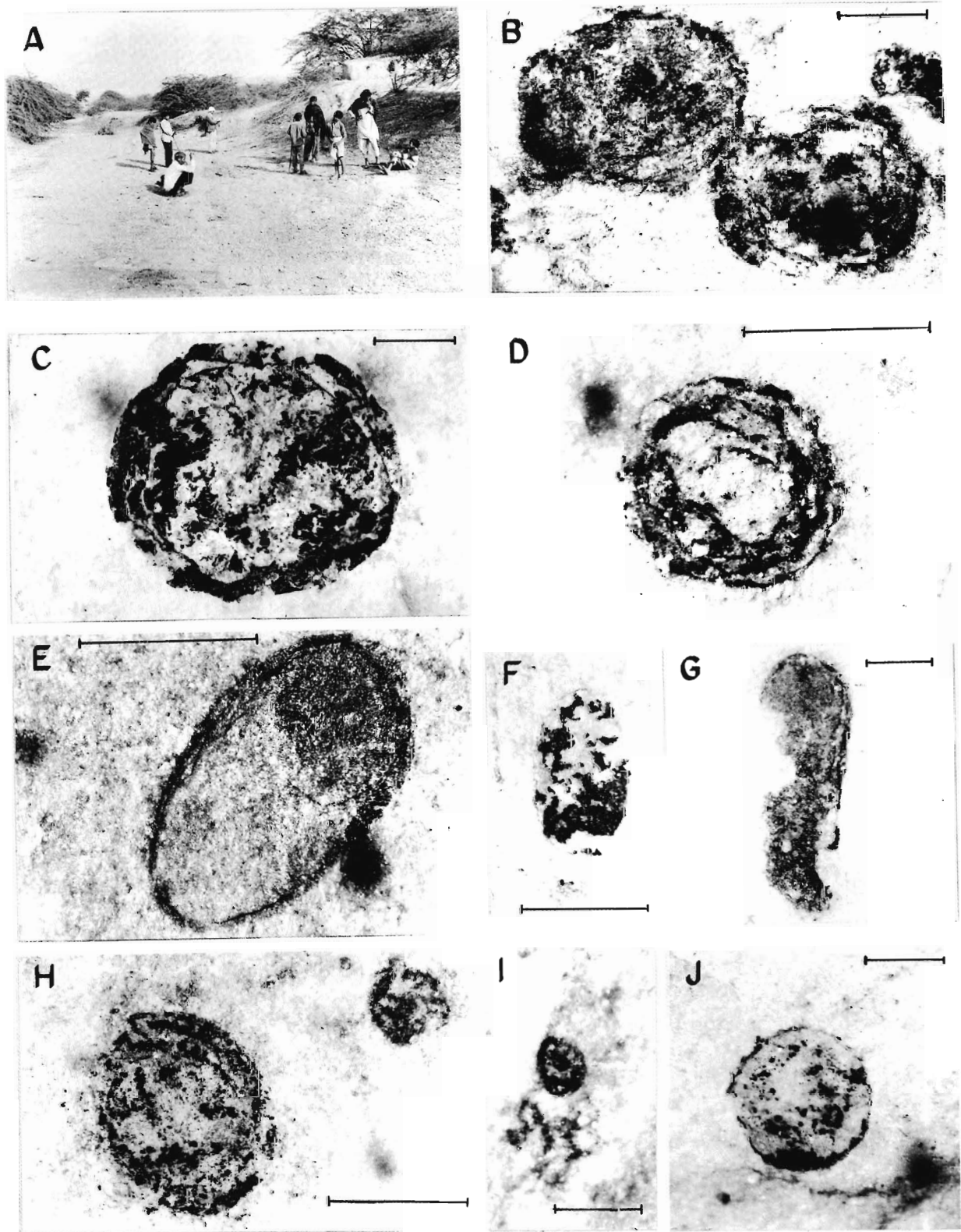


Figure 5. Photomicrographs of the carbonaceous megafossils from the Dholpura Shale. Scale bar represents 1 mm for all figures.

A- Field photograph, Dholpura Shale in Kunwarpura Bhatta locality of the Balwan area near Indergarh, Rajasthan. B- *Chuaria circularis*, Dholpura Shale, sample No. KP-10. C- *Chuaria circularis*, Dholpura Shale, sample No. KP-2. D- *Chuaria circularis*, Dholpura Shale, sample No. KP-14. E- *Tawuia dalensis*, Dholpura Shale Sample No KP- 22. F- *Tawuia dalensis*, Dholpura Shale Sample No KP- 33. G- *Tawuia dalensis*, Dholpura Shale Sample No KP- 32. H- *Chuaria circularis* of variable diameters, Dholpura Shale Sample no. KP-7. I- Very small sized *Chuaria circularis*, Dholpura Shale, Sample No. KP- 17. J- *Chuaria circularis*, Dholpura Shale, Sample No. KP-8

recommended.

In northern Anhui, *Chuarina-Tawuia* assemblage is considered to indicate pre-Sinian age (Sun *et al.*, 1986), but the occurrence of *Chuarina* in the Upper Sinian Shijia Formation, and in the Lower Cambrian Gouhou Formation also suggest a younger age. *Tawuia* has been reported from the Dengying Formation (Upper Sinian), Jiucheng County of Eastern Yunnan (Zang and Walter 1992). The *Chuarina-Tawuia* assemblage, therefore, has a long time range but was abundant in the Late Proterozoic (Zang and Walter, 1992). The available reports of megafossils of probable algal affinities indicate that the emergence of megascopic life might have occurred by mid-Proterozoic times.

In the present context, the *Chuarina-Tawuia* assemblage in the uppermost horizon of the Vindhyan Supergroup represents marker assemblage of pre-Vendian or Neoproterozoic age in the absence of typical Vendian microfossils (in Bhandar Group), especially the acanthomorphic acritarchs (Kumar and Srivastava, 1997a) as well as megafossils (Kumar and Srivastava, 1997b). *Chuarina-Tawuia* assemblage is also a useful and significant marker for broad intercontinental correlation of the Meso-Neoproterozoic sequences (Sun Weigou, 1987). Their global distribution can be used to assign the age for other coeval deposits elsewhere in the Precambrian terrains of the world.

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