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CARBONACEOUS MEGAFOSSILS FROM THE NEOPROTEROZOIC BHANDER GROUP, CENTRAL INDIA

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ABSTRACT

Ten carbonaceous megafossils representing seven species belonging to six genera are described and three megafossils are informally described from the Neoproterozic Bhander Group. These are *Chuaria circularis* Walcott, *Chuaria dulniensis* sp nov., *Tawuia dalensis* Hofmann, *Chambalia minor* Kumar, cf. *Phascolites symmetricus* Duan et Du, *Bhanderia maiharensis* gen. & sp. nov., cf. *Lanceoforma* sp. Walter *et al.*, Form A, Form B and Form C. Out of these, one is a new genera and one is a new species, and three are unnamed forms. The fossils are reported from the shales belonging to the Bhander Limestone and Sirbu Shale of the Bhander Group exposed around Maihar township, Satna district, Madhya Pradesh. *Chuaria* is the most abundant form and recorded both in the Bhander Limestone and Sirbu Shale, but *Tawuia* is very rare, recorded only in the Bhander Limestone. A new species *Chuaria dulniensis* is erected to describe a form much similar in appearance to *Chuaria circularis* but having an additional ring around circular to elliptical carbonaceous body. This additional morphological feature appears to be an evolutionary modification in *Chuaria*. *Bhanderia* is erected to describe a broad ring-like body. A genetic relationship is suggested between *Chuaria dulniensis, Chuaria circularis* and *Bhanderia*. All the forms have algal affinity. The forms described informally as Form A and Form B have filamentous morphology with beads and Form C has a ribbon like morphology.

Key words: Carbonaceous megafossils, Neoproterozoic, Vindhyan Supergroup, Bhander Group, Central India.

INTRODUCTION

The record of any evidence of life in the Precambrian sequences is very important for understanding the evolution of early life. A large number of reports of organic- walled microfossils from the black bedded cherts have improved our knowledge of early microbial life. However, records of megafossils are not only very rare, but their biogenicity in most of the cases is very difficult to prove. Many earlier reports of megafossils, including trace fossils, have been subsequently discarded as nonfossils, dubiofossil or pseudofossils. It is, however, easier to prove the biogenicity of the carbonaceous megafossils, hence any report of carbonaceous megafossils can be considered significant. Such reports, however, are hard to come by in spite of the fact that the Precambrian successions occupy large areas and attain huge thickness in many parts of the world. The rocks of the Mesoproterozoic to Neoproterozoic Vindhyan Basin are well exposed in central India, which are more or less undisturbed and unmetamorphosed. Jones (1909) first reported carbonaceous discs from the Suket shales of the Semri Group, the oldest group of the Vindhyan Supergroup. These attracted the attention of many later workers (see Kumar, 2001), but discovery of carbonaceous megafossils from the younger groups were reported only recently. Kumar and Srivastava (1997) reported the *Chuaria -Tawuia* assemblage from the Bhander Group, and the same assemblage has been recorded by Rai, Shukla and Gautam (1997) from the underlying Rewa Group. Recently, Srivastava (2002) has also reported this assemblage from the Dholpura Shale, the youngest unit of the Vindhyan Supergroup in the western part of the Vindhyan Basin in Rajasthan. The paper describes carbonaceous megafossils from the Bhander Group from the Maihar area, Satna district, Madhya Pradesh and discusses their significance.

GEOLOGICAL SETTING

The rocks of the Vindhyan Supergroup are well exposed in central India. It occupies an area of about 1,04,000 Km^2 stretching from Dehri On Son in Bihar to Chittorgarh in Rajasthan (fig.1). The dominant lithologies are sandstone, conglomerates, porcellanites, shales, and carbonates. The rocks are unmetamorphosed and are very little deformed. They show excellent preservation of sedimentary

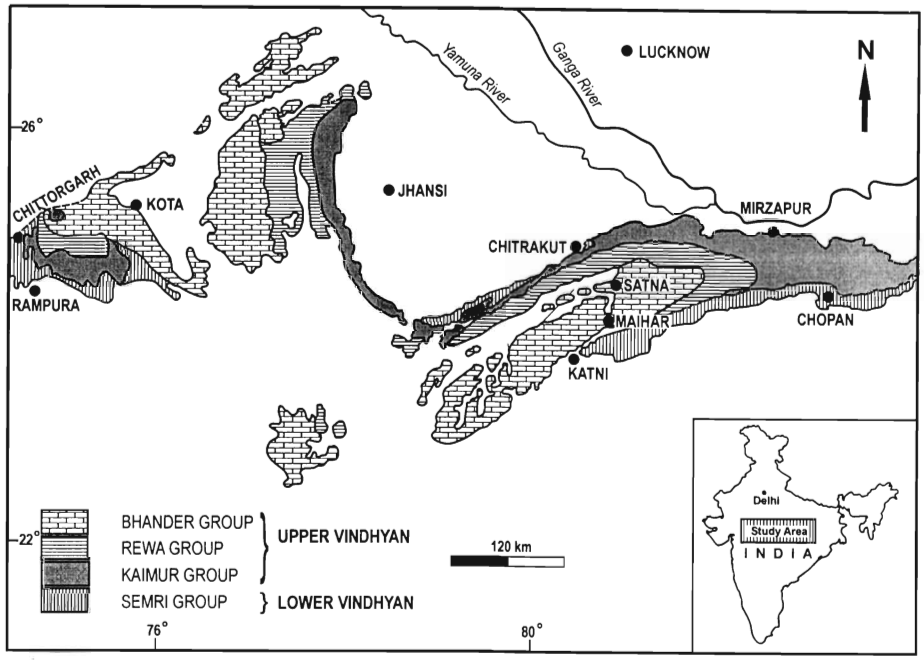


Fig.1. Geological and location map of the Vindhyan Basin (after Krishnan and Swaminath, 1959).

structures and are considered to be a deposit of shallow marine environments in an intracratonic basin. In the eastern part of the Vindhyan Basin in the Son Valley area, the Vindhyan rocks have been subdivided into four series by Auden (1933). In recent years the series term has been replaced by group, and the rocks of the Vindhyan Basin have been given the rank of a supergroup. Thus, the four groups are the Semri Group, the Kaimur Group, the Rewa Group and the Bhander Group (Table 1). The Semri Group is traditionally designated as the Lower Vindhyan, and the Kaimur, Rewa and Bhander Groups are referred as the Upper Vindhyans. Each group has been further subdivided into formations and members. The Vindhyan rocks show much facies variation, and different lithologic successions are developed in different areas.

In the Maihar area, Madhya Pradesh, the Bhander Group is well developed, and has been subdivided into four formations namely the Ganurgarh Shale, the Bhander Limestone, the Sirbu Shale and the Maihar Sandstone (Table 1, fig. 2). The lowermost unit, the Ganurgarh Shale, is in general poorly developed. The Bhander Limestone is well exposed in the low lying areas south and east of Maihar township, especially in the Tamas River

EXPLANATION OF PLATE I

Scale bar is equal to 1mm for all photomicrographs except for k where it is equal to 0.5 mm.

a. ***Chuaria circularis***, Sample no. D66, Bhander Limestone, Dulni area.

b. ***Chuaria circularis***, Sample no. M42B, Sirbu Shale, Rampura area.

c. ***Chuaria circularis***, Sample no. D14, Bhander Limestone, Dulni area.

d. ***Chuaria circularis***, Sample no. DD3, Bhander Limestone, Dulni area.

e. ***Chuaria circularis***, Sample no. MS3, Sirbu Shale, Rampura area.

f. ***Chuaria circularis***, Sample no. MS3, Sirbu Shale, Rampura area. Enlarged view of fig-e

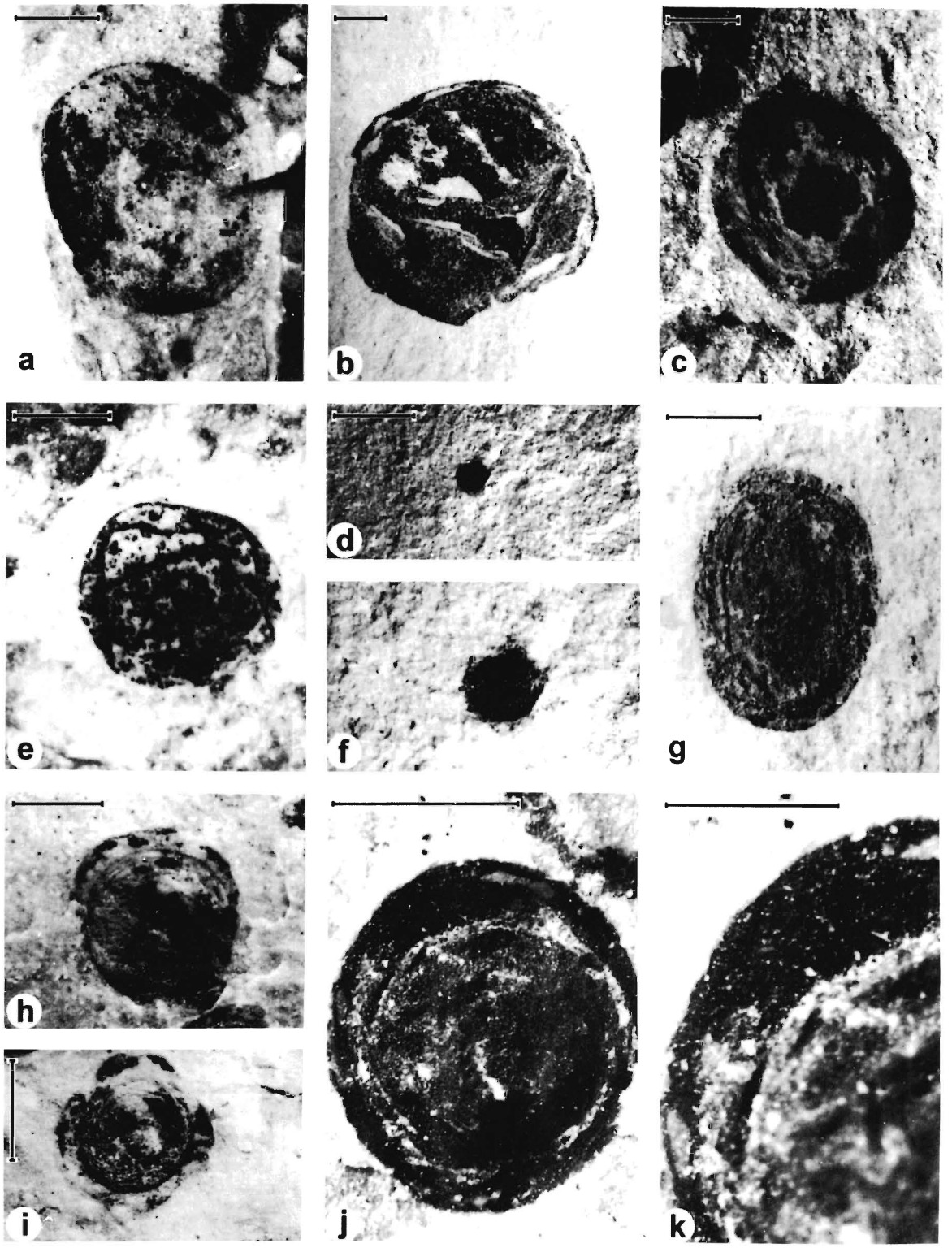
g. ***Chuaria circularis***, Sample no. M42B, Sirbu Shale, Rampura area.

h. ***Chuaria dulniensis***, Sample no. D11, Bhander Limestone, Dulni area.

i. ***Chuaria dulniensis***, Sample no. D11, Bhander Limestone, Dulni area.

j. ***Chuaria dulniensis***, Sample no. D11, Bhander Limestone, Dulni area.

k. ***Chuaria dulniensis***, Sample no. D11, Bhander Limestone, Dulni area. Closeup of fig.-h showing smooth ring.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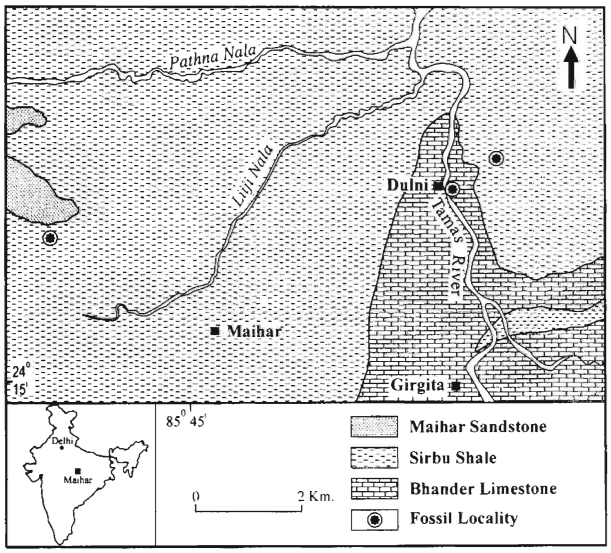


Fig.2. Geological map of the Maihar area, Madhya Pradesh (simplified after Bhattacharyya, 1993).

Table 1. Lithostratigraphy of the Maihar area, Satna district, Madhya Pradesh.

Supergroup	Group	Formation
		Maihar Sandstone
	Bhander Group	Sirbu Shale
		Bhander Limestone
		Ganurgarh Shale
	Rewa Group	Sandstone and shale
Vindhyan Supergroup	Kaimur Group	Sandstone and shale
———	UNCONFORMITY	———
		Rohtas Formation
	Semri Group	Kheinjua Formation
		Porcellanite Formation
		Basal Formation
———	UNCONFORMITY	———
Bundelkhand granites /Bijawar phyllites		

valley section. Good exposures can also be seen in a number of limestone quarries. The estimated thickness of the Bhander Limestone is ca. 50 m (Bhattacharya, 1993). It is represented by limestone and subordinate dolostone and shale. The limestone shows excellent development of the columnar stromatolite *Baicalia baicalica* (Kumar, 1976), whose bioherms attain a height of a few meters. Kumar and Srivastava (1997) have recorded the *Chuaria –Tawuia* assemblage from the rocks of the Bhander Group exposed around Maihar. Recently, Kumar (1999a) has also reported siliceous sponge spicule-like structures from a bedded black chert lens associated with the Bhander Limestone.

The Bhander Limestone is conformably overlain by the arenaceous Sirbu Shale, which occupies much of the area around Maihar. It is represented by shales, siltstones and sandstones. It acquires a thickness of ca. 140 m and the best exposures can be seen in the nala cuttings around Maihar township and also on the Maihar - Rampura motor road. The Sirbu Shale grades into the Maihar Sandstone which constitutes the youngest unit of the Vindhyan Supergroup and forms prominent scarps in the western part of the area. The environment of deposition of the Bhander Limestone is considered to be an intertidal carbonate flat, while the Sirbu Shale and Maihar Sandstone are considered to be a lagoon and coastal sand complexes respectively (Singh, 1976).

AGE

In general, the Vindhyan rocks are poorly dated, and no radiometric dates are available for the Bhander Group. Thus, the age of the Bhander Group can be inferred only on the basis of the age assigned to the other units of the Vindhyan Supergroup. Vinogradov *et al.* (1964) were the first to date the glauconite of the Semri and Kaimur

EXPLANATION OF PLATE II

Scale bar is equal to 1mm for all photomicrographs.

a. Form A, Sample no. D66, Bhander Limestone, Dulni area.

b. ***Chambalia minor***, Sample no. DS5, Sirbu Shale, Rampura area

c. ***Chambalia minor***, Sample no. DS5, Sirbu Shale, Rampura area

d. ***Tawuia dalensis***, Sample no. D38, Bhander Limestone, Dulni area.

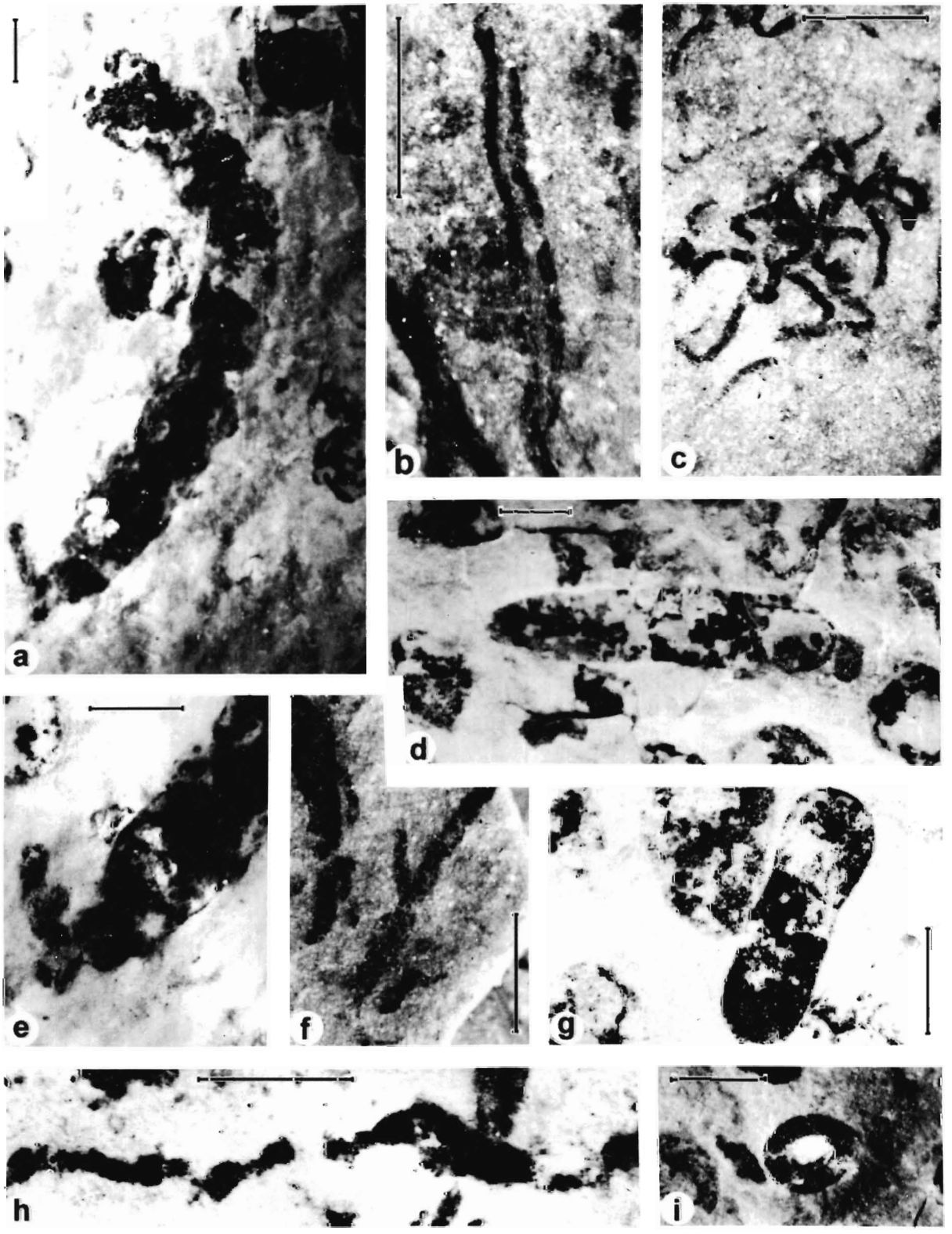
e. Form A, Sample no. D66, Bhander Limestone, Dulni area. Closeup view of the holdfast apparatus in Plate II-a.

f. ***Chambalia minor***, Sample no. DS5, Sirbu Shale, Rampura area

g. ***Tawuia dalensis***, Sample no. D18, Bhander Limestone, Dulni area.

h. Form B, Sample no. M-99-1, Bhander Limestone, Dulni area.

i. ***Bhanderia maiharensis***, Sample no. DD18, Bhander Limestone, Dulni area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Groups by the K/Ar method. These dates were recalculated by using a later recommended constant by Kreuzer *et al.* (1977). They suggested 1080 ±40 Ma and 890±40 Ma for the glauconites of the Kheinjua Formation (the Semri Group) and Kaimur sandstones respectively. A kimberlite pipe which has intruded the Kaimur rocks at Majhgawan has been dated by the Rb-Sr method as 1140±12 Ma by Crawford and Compston (1970) and by Kumar *et al.* (1993) as 1067±31 Ma. Crawford and Compston (1970) have also suggested that the age of the Vindhyan Supergroup extends over a very long period from at least 1200 Ma and possibly 1400 Ma to perhaps 550 Ma or even later. According to them, the base of the Upper Vindhyan is about 1150 Ma or more. Recently, Rasmussen *et al.* (2002) have dated the silicified tuffs bounding the Chorhat Sandstone (= the Kheinjua Formation) by SHRIMP U-Pb zircon as 1628±8 to 1599±8, and Ray *et al.* (2002) dated the silicified volcanic rock of the Porcellanite Formation by U – Pb zircon as 1632 Ma. These ages pushed the beginning of the Vindhyan sedimentation to ca. 1800 Ma, about 400 Ma older than the generally accepted beginning of about 1400 Ma. The age assignment for the Vindhyan rocks is broadly in agreement with the age given by stromatolite assemblages of the Semri and Bhander Groups. The Semri Group is charactersied by the abundance of coniform stromatolites represented by *Thyssagates, Ephyaltes, Calypso, Cyathotes* and *Siren* (Kumar, 1999b). The other columnar forms are *Kussiella, Jacutophyton, Colonnella,* and unnamed very passively branched forms. This assemblage is suggestive of a Lower to Middle Riphean age. No stromatolite has been recorded from the Kaimur and Rewa Groups as no carbonate horizon is present in them. The uppermost Bhander Group displays extensive developments of stromatolites both in the Maihar area of M.P., and Kota and Bundi areas of Rajasthan. The stromatolites of the Bhander Group are represented by *Baicalia – Tungussia – Inzeria* assemblage. All the forms show very active branching. However no *Conophyton* has been recorded from the Bhander Group. The stromatolite assemblage has been assigned to an Upper Riphean age. Since *Conophytons* are poorly developed in the Vendian, and the thrombolites dominate in the Phanerozoic, the Upper Riphean age of the stromatolite- bearing Bhander Limestone appears justified.

There are only a few reports that have described microbiotas from petrographic thin sections of the bedded cherts, but none of the reported microfossils are age indicators except for coiled filaments of *Obruchevella* from the Sirbu shales of the Bundi area, Rajasthan (Srivastava and Kumar, 1997). On this basis, the Upper Riphean age has also been suggested.

Venkatachala *et al.* (1996) have reviewed the reports of trace fossils and body fossils from the Vindhyan rocks and suggested that many of the reported remains appear to be of doubtful biogenicity. Kumar (1999c, 2001) has even doubted the biogenicity of the recently discovered trace fossils of triploblastic animals from the Chorhat Sandstone (the Kheinjua Formation) by Seilacher *et al.* (1998), brachiopod and shelly fossils from the Rohtas Formation by Azmi (1998, 1999a, b, c), and *Spriggina* from the Semri Group by Kathal *et al.* (2000). Hence no meaningful conclusion on the age

EXPLANATION OF PLATE III

Scale bar is equal to 1 mm for all the photomicrographs

a. Form C, Sample no. M-132, Sirbu Shale, Rampura area.

b. ***Bhanderia maiharensis***, Sample no. D77, Bhander Limestone, Dulni area.

c. ***Bhanderia maiharensis***, Sample no. M-99-7, Bhander Limestone, Dulni area.

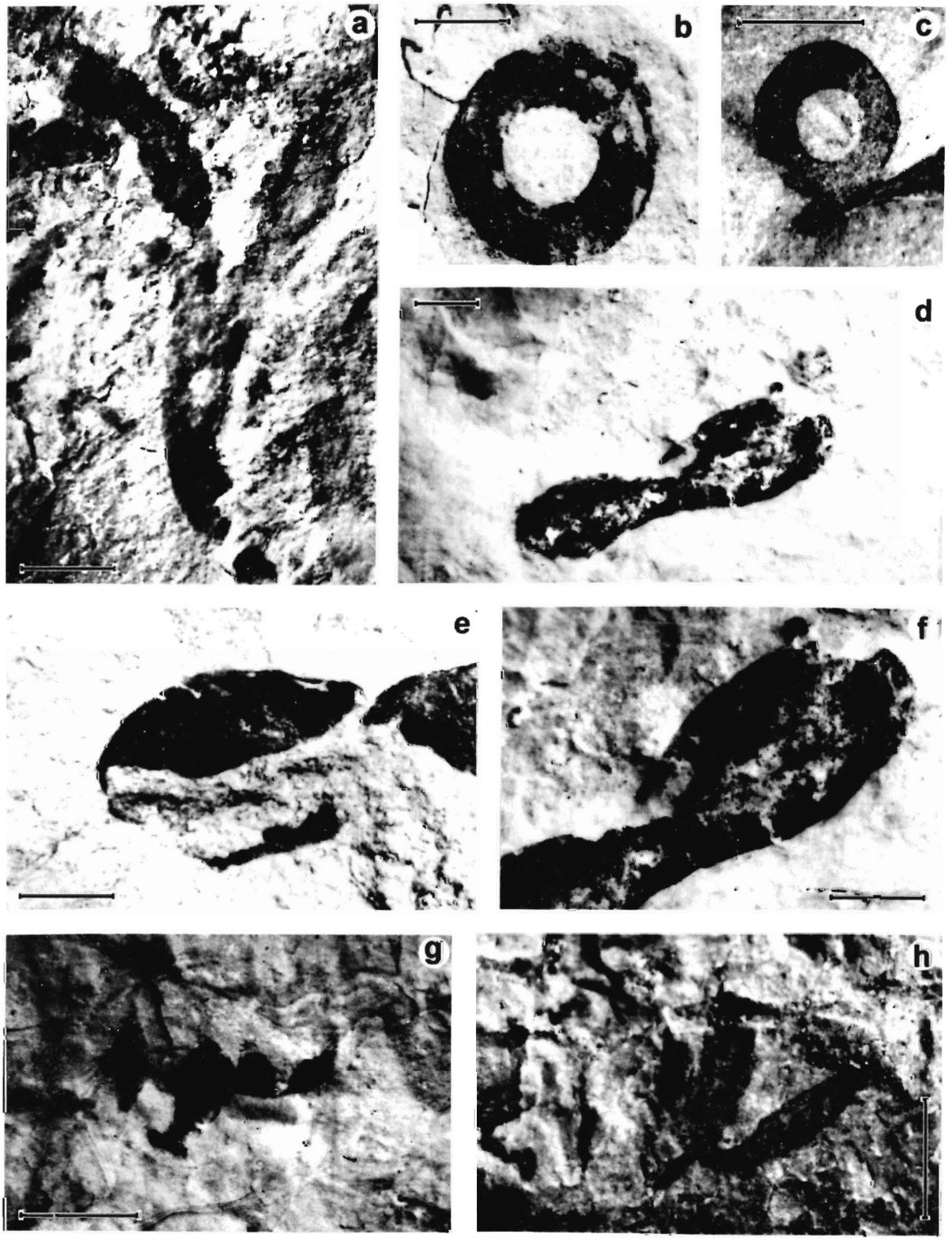
d. ***Phascolites symmetricus***, Sample no. M-68, Sirbu Shale, Rampura area.

e. cf. ***Lanceoforma*** sp. , Sample no. M-65a, Sirbu Shale, Rampura area.

f. ***Phascolites symmetricus***, Sample no. M-68, Sirbu Shale, Rampura area. Enlarged view of microphotograph of Plate III- d.

g. cf. ***Lanceoforma*** sp. Sample no. M-65a, Sirbu Shale, Rampura area.

h. cf. ***Lanceoforma*** sp. Sample no. M-89, Sirbu Shale, Rampura area.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of the Vindhyan rocks can be drawn on the basis of such problematic finds.

On the basis of carbon isotope data an attempt has also been made by Friedman *et al.* (1996) and Friedman and Chakraborty (1997) to suggest a Precambrian-Cambrian boundary within the Bhander Group. However, Kumar (1998) has pointed out that the variation recorded by them in $\delta^{13}C$ values can not be taken as an excursion as difference in the values is of only 2.1‰ (PDB) and moreover, the conclusion is based on only four analyses for a succession which is more than 100 m thick. No Cambrian fossil has been reported from the Bhander Group to date. Recently, a Neoproterozoic interval has been suggested for the deposition of the Upper Vindhyan on the basis of the carbon, oxygen and strontium isotope geochemistry of the Bhander Group by Kumar *et al.* (2002). Thus, the age of the Bhander Group can be suggested to be somewhere between Upper Riphean and Vendian.

METHODOLOGY

The megafossils were studied under a stereozoom Wild microscope, and the photography was done using Agfa TR-13 film. Samples deposited in the Museum of the Geology Department, University of Lucknow, Lucknow by Kumar and Srivastava (1997) have also been studied. All the samples have been deposited in the Museum of the Geology Department, University of Lucknow, Lucknow, U.P.

TAXONOMY

Megafossils

Ten taxa representing seven species belonging to six genera are described, and three unnamed megafossils reported informally as Form A, Form B and Form C. Megafossils have been recorded only in the greenish grey shales of the Bhander Limestone and yellow and grey shales of the Sirbu Shale. The fossil-bearing horizons are marked in fig. 3. The fossils are seen on bedding surfaces of the shales. Occasionally, the fossils are also seen within the bed. The fossils in general are marked by the carbonaceous matter, but they are also preserved as impressions.

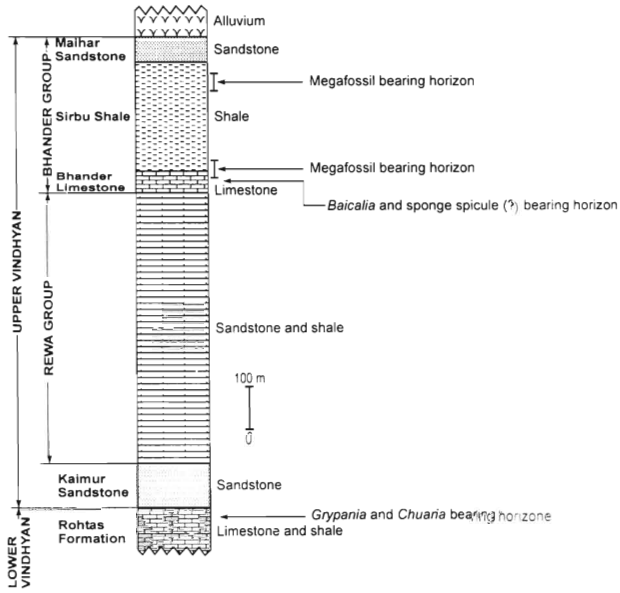

Fig.3. Stratigraphic section of the Bhander Group showing positions of the fossiliferous horizons.

SYSTEMATIC PALAEONTOLOGY

Division **Chlorophyta / Xanthophyta** ?

Class **Chlorophyceae/ Xanthophyceae** ?

Order **Ulotrichales/ Vaucheriales** ?

Family **Ulotrichaceae/ Vaucheriaceae** ?

Genus ***Chuaria*** Walcott 1899 emend. Vidal and Ford 1985

Chuaria circularis Walcott, 1899 emend. Vidal and Ford, 1985

(Pl. I, figs. a-g)

Synonymy: For synonymies see Ford and Breed, 1973; Maithy and Shukla, 1984; Sun, 1987; Vidal and Ford, 1985

Sample: Sample no. D/46, D/67, D/110, D/113, M/88, M/66

Locality: Maihar, Satna district, Madhya Pradesh

Stratigraphic Position : Bhander Limestone and Sirbu Shale

Lithology: Greyish green and yellow shales.

Description: Circular to elliptical compressions on bedding surfaces. Compressions are made up

of carbonaceous matter. When the carbonaceous matter is not preserved, it is marked by a distinct impression. Wrinkles are common but not well preserved in smaller forms. Diameter ranges from 0.2 mm to 5.0 mm with mean as 1.7 mm (N = 268). Specimens occur isolated and rarely in contact with one another. Overlapping is also very rare. In vertical sections the compressions appear as dark lines.

Discussion: *Chuaria* has been an enigma for palaeontologists since its description by Walcott in 1899. Many attempts have been made to assign it the diagnostic characters and to give it a biological affinity. Steiner (1997) reviewed the different views concerning the identification and assignment of *Chuaria circularis* including the size range. Though originally *Chuaria circularis* was described as a carbonaceous megafossil, many authors have suggested different dimensions for its identification (see Ford and Breed, 1973; Vidal and Ford, 1985; Jankauskas, 1989). Kumar (2001) has recently suggested that *Chuaria* should be identified megascopically only, and that the lower size limit of *Chuaria* should be taken as 0.2 mm. Kumar (2001) has also erected a new species *Chuaria vindhyanensis* with size range from 0.2 mm to 1.45 mm. However, in the present collection only one species could be recognized, as the size distribution for both shorter and longer diagonal is unimodal. The maximum mode for both longer and shorter diameters is at 1.45 mm (fig. 4). In comparison to *Chuaria circularis* of the Suket Shale (the Semri Group; Kumar, 2001) with a mean diameter of 2.48 mm and the size range from 2 – 9.5 mm, the *C. circularis* of the Bhander Group is smaller in dimensions with a mean diameter of 1.69 mm and size range of 0.2 - 5.0 mm. Thus, the mean diameter as well as size range is narrower in the Bhander Group forms in comparison to *C. circularis* of the older Suket Shale.

Steiner (1997) has reviewed the taxonomic assignment of *Chuaria* and suggested that it represents a form taxon of probably different biological affinities including mainly prokaryote colonies and outer envelopes. Earlier, Hofmann (1977) also suggested that *Chuaria* most probably comprises different biological groups. Duan (1982) postulated that it is multicellular, probably a planktic alga, while Sun (1987) compared it with recent cyanobacterium *Nostoc* colonies. Kumar (2001) has suggested that *Chuaria* may be a cyst of a Chlorophycean/ Xanthophycean multicellular filamentous thallophytic plant.

Chuaria dulniensis n. sp.

(Pl. I, figs. h, i, j & k)

Holotype : Sample no. D/11

Paratype : Sample no. D/66

Locality : Dulni, Maihar area, Satna district, Madhya Pradesh

Stratigraphic Position : Bhander Limestone

Lithology : Grey shale

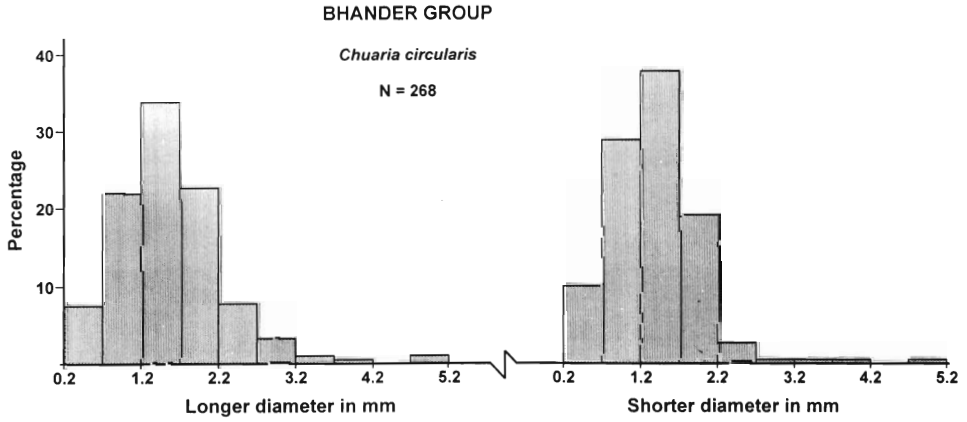

Fig. 4. Histogram for the diameter of *Chuaria* of the Bhander Group.

Etymology : Species is named after the village Dulni where the type species was collected

Diagnosis: Circular to elliptical compressions on the bedding surface with a distinct outer ring. Compressions are made up of carbonaceous matter but where carbonaceous matter is not preserved it is marked by a distinct impression. It has two parts, a circular to elliptical body which is characterized by well marked wrinkles. It is surrounded by a ring which does not show any wrinkle. The diameter of the inner body ranges from 1.0 to 1.6 mm with mean as 1.35 mm (N = 16) and the maximum diameter of the outer ring varies from 1.3 to 2.1 mm with mean as 1.85 mm (N = 16). The histogram is polymodal to bimodal with maximum mode for both inner and outer body as 1.35 and 2.05 mm respectively (figs. 5 & 6). Width of the ring varies from 0.7 to 1.5 mm.

Discussion: It differs from *Chuaria circularis* in having a ring around a circular or elliptical body. This ring is seen only in the equatorial section. This conclusion is drawn on the basis of four three dimensionally preserved specimens where it does not envelop the spheroidal/elliptical body. It is also inferred that the wrinkles were originally preserved in the spheroidal body. The presence of a ring around *Chuaria* is either due to taphonomy or is an additional morphological feature added to *Chuaria* due to evolutionary modification.

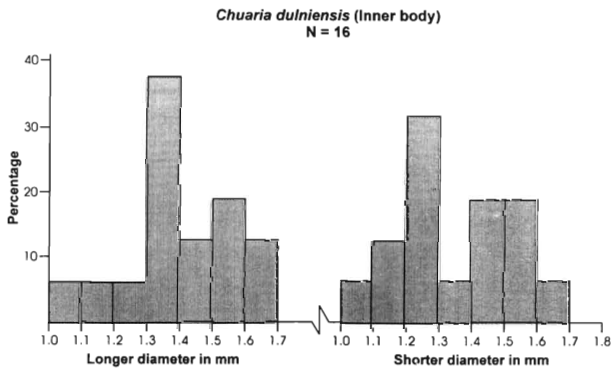

Fig. 5. Histogram for the diameter of the inner body of *Chuaria dulniensis*.

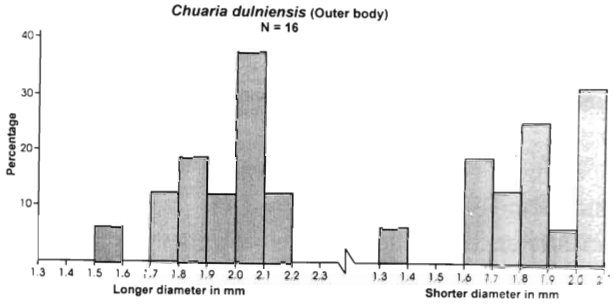

Fig. 6. Histogram for the diameter of outer body of *Chuaria dulniensis*.

Division **Chlorophyta/ Xanthophyta** ?

Class **Chlorophyceae/Xanthophyceae** ?

Order **Ulotrichales/ Vaucheriales** ?

Family ***Ulotrichaceae/Vaucheriaceae*** ?

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

Tawuia dalensis Hofmann, 1979

(Pl. II, figs. d & g)

Synonymy: see Sun, 1987; Hofmann, 1992a. Zang and Walter, 1992

Sample: Sample no. D/67, D/76, D/82

Locality: Maihar, Satna district, Madhya Pradesh

Stratigraphic Position : Bhander Limestone and the Sirbu Shale

Lithology: Dark grey and yellow shales

Description: Elongated rod- and ribbon- like impressions, short to slender. Parallel-sided but slight pinching is also noted. Ends subrounded to flat. Tapering at both the ends also noted. Very thin film of carbonaceous matter preserved. Width of the wall is 0.01 mm. Elongated ribbons are generally straight. Diameter varies from 0.8 to 2.0 mm. Maximum recorded length is 9.3 mm (5 samples traced).

Discussion: It is a rare form in the present assemblage. *Chuaria circularis* is also associated with *Tawuia dalensis* as has been observed in many areas of the world (see Hofmann, 1981, 1992a, b; Kumar, 2001). Kumar (2001) has suggested a genetic link between *Chuaria* and *Tawuia* and has

suggested that both are parts of a multicellular plant *Radhakrishnania,* a thallophytic plant of Chlorophycean / Xanthophycean affinity.

Division **Chlorophyta**

Class **Chlorophyceae**

Order **Cladophorales**

Family **Cladophoraceae**

Genus ***Chambalia*** Kumar, 2001

Chambalia minor Kumar, 2001

(Pl. II, figs. b, c & f)

Sample no.: DS/5

Locality: Maihar, Satna district, Madhya Pradesh

Stratigraphic Position: Bhander Limestone

Lithology: Grey shales

Description: Thread like carbonaceous compressions seen on the bedding surface. Diameter varies from 0.05 to 0.15 mm with mean as 0.06 mm (N = 8). Length can be measured in millimeters. Compressions occur as cluster as well as isolated. Branching is seen but not very common and is acute. In longer threads, slight tapering is seen. No internal structure is recorded.

Discussion: It compares well with the form described by Kumar (2001) from the Suket Shale of the Semri Group where it occurs in association with *Chuaria* and *Tawuia*. In the present assemblage also, it is seen in association with *Chuaria* and *Tawuia* and is recorded only in the grey shales of the Bhander Limestone. Kumar (2001) has suggested its affinity with a Cladophoracean form. It must have flourished in a very low energy environment of deposition.

Incertae sedis

Genus ***Bhanderia*** n. gen.

Type Species: *Bhanderia maiharensis* n. gen.

Etymology: Genus is named after the Bhander Group.

Diagnosis: Circular and elliptical compressions marked by carbonaceous matter with a circular or elliptical hole. Boundaries are sharply marked and are smooth. However, cracks are seen which suggests that it is made up of very thin carbonaceous film. No internal structure is evident.

Discussion: No known form has a comparable morphology and it is not possible to assign this genus to any extant plant or animal form. However, it has a distinct similarity to the outer rim in *Chuaria dulniensis*. There is a possibility that the ring in *Chuaria dulniensis* was detached and preserved as *Bhanderia* as it has a comparable size.

Bhanderia maiharensis n. gen.

(Pl. II, fig. i; Pl. III, figs. b-c)

Holotype: Sample no. D/77

Paratype: Sample no. DD/18, D/99-7

Locality: Maihar, Satna district, Madhya Pradesh

Stratigraphic Position: Bhander Limestone

Lithology: Grey shale

Etymology: The genus is named for its occurrence around Maihar.

Diagnosis: Circular to elliptical compressions marked by carbonaceous matter with a circular to elliptical hole. The boundaries are sharp. No internal structure is seen. The maximum diameter ranges from 1.2 to 2.8 mm with mean as 2.02 mm (N = 6). The diameter of the hole ranges from 0.5 to 1.3 mm with mean value as 0.92 mm (N = 6).

Discussion : As for the genus

Genus Lanceoforma striata Walter, Oehler and Oehler, 1976

cf. *Lanceoforma* sp.

(Pl. III, figs. e, g & h)

Sample no.: M/65a, M/89

Locality: Maihar, Satna district, Madhya Pradesh

Stratigraphic Position : Sirbu Shale

Lithology: Yellow shale

Diagnosis: Lanceolate carbonaceous compression with a thin tail or stalk at one end. The

maximum width of the structure is between 0.30 to 1.30 mm and length varies from 1.3 to 3.0 mm. Width of the tail varies from 0.05 to 0.1 mm. Four specimens located.

Discussion : Morphologically, it is comparable to *Lanceoforma* sp. However, in the present form the tail is also seen.

Genus ***Phascolites*** Duan et Du, 1985 in Duan *et al.*, 1985

cf. *Phascolites symmetricus* Duan et Du, 1985

(Pl. III, figs. d & f)

Sample no. : M/68

Locality : Maihar, Satna district, Madhya Pradesh

Stratigraphic Position : Sirbu Shale

Lithology: Yellow shales

Description: It is a stubby rod shaped symmetrical carbonaceous compression with rounded ends whose central part is compressed. It is made up of brown coloured carbonaceous matter. Wrinkles are seen. Maximum length is 5.9 mm. Minimum width at the centre is 1.1 mm and maximum width near the margin is 1.9 mm. Margins are smooth. A single specimen traced.

Discussion: It shows close similarity with *Phascolites symmetricus* described by Duan and Du (1985) from Longfengshan Hill, China. But Hofmann (1992b) has interpreted the morphology of this form due to overlapping of two *Shouhsienia* specimens, and suggested that this genus should not be considered as an independent morphotaxa. In the present case no such superimposition is clearly noted but only a single specimen is traced. Hence, the position of the form as an independent taxon is still not clear.

Form A

(Pl. II, figs. a & e)

Sample no. : D/66a, D/66b

Locality: Dulni, Satna district, Madhya Pradesh

Stratigraphic Position: Bhander Limestone

Lithology: Grey shales

Description: A compressed tube like carbonaceous filament with beaded appearance, seen on the bedding surface in which the beads or spheroids are placed adjacent to each other. It gives an impression as if a number of compressed discs are arranged in a row. Eleven discs counted. Filament shows tapering and is slightly curved. One end flat and the other is marked by the attachment of a thin, slightly undulating plate at an angle of 80° with the filament. The maximum length of the filament is 11.2 mm. Maximum width 1.4 mm and minimum width is 0.8 mm. Length of the plate at one end is 2.2 mm and thickness is 0.4 mm. (A single specimen with both counter parts available).

Discussion: In appearance the beads resemble with *Chuaria* and the form gives an impression as if a number of *Chuaria* like forms are arranged in a row enclosed within a sheath. However no wrinkles are seen. A distinct tapering and an attached plate like structure supports that it may be a new form. The plate like feature can be inferred as a hold fast apparatus. It may have Chlorophycean affinity. There is also a possibility that it simply represents a chain made up of *Chuaria* forms. Since only one form is recorded it is described informally.

Form B

(Plate II, fig. h)

Sample no.: M-99-1

Locality: Dulni, Satna district, Madhya Pradesh

Stratigraphic Position : Bhander Limestone

Lithology: Grey shales

Description: Compressed carbonaceous filamentous form with occasional beads. Straight to slightly curved. Width of the form is 0.1 mm and maximum diameter of the beads is 0.2 mm. Maximum recorded length is 4 mm. 5 samples recorded.

Discussion: It is a poorly preserved form. Presence of bead -like feature is the diagnostic

character of this form. It has some resemblance with *Vendotaenia* Gnilovskaya 1971. No affinity is suggested.

Form C

(Pl. III, fig. a)

Sample no. : M/132

Locality: Maihar, Satna district, Madhya Pradesh

Stratigraphic Position: Sirbu Shale

Lithology: Yellow shale

Description: Compressed carbonaceous ribbon like form, straight to sinuous, seen on bedding surface. Branching is seen. It is passive and after branching the filament attains the same width. Maximum recorded length is 11 mm and maximum width is 1.4 mm. No internal structure is seen. Four forms have been traced.

Discussion: Characteristic feature of the form is well marked megascopic size and passive branching. It may belong to Chlorophyceae/ Rhodophyceae.

DISCUSSION AND CONCLUSIONS

1. The occurrence of carbonaceous megafossils in the Bhander Group is facies controlled and the fossils are preserved only in the shales.

2. *Chuaria circularis* is the most abundant form and is well represented in both the Bhander Limestone as well as in the Sirbu Shale. In the Bhander Limestone it occurs in association with *Tawuia dalensis* .

3. *Tawuia* is very rare and recorded only in the Bhander Limestone. Kumar (2001) has suggested that *Tawuia* and *Chuaria* represent parts of a multicellular thallophytic plant which was benthic and attached to a substrate. *Tawuia* could be preserved only where it was growing and in the adjacent or nearby areas where it could be transported. It could not be transported to long distances as was the case with the more sturdy *Chuaria circularis* which was dispersed to far away places by currents and waves. This model gets confirmation from the present assemblage also. The fossil-bearing Bhander Limestone horizon was deposited in the lower part of an intertidal zone where there was an abundance of *Chuaria* but very rare occurrence of *Tawuia,* while the fossil bearing horizons in the Sirbu Shale must have been deposited in the middle part of the intertidal zone where *Tawuia* is not recorded.

4. The genus *Chambalia* was erected by Kumar (2001) to include very thin filamentous ribbon like forms from the Suket shales which show branching and occur in association with *Chuaria* and *Tawuia*. It occurs in a similar environmental setting and association in the Sirbu shales.

5. The *Chuaria dulniensis* is similar to *Chuaria circularis* except that it has an additional ring-like morphology around the equatorial part. This feature may be due to taphonomy or is an additional morphological feature developed by *Chuaria* which must have helped in its dispersal to new and far flung areas. In our opinion it appears to be an evolutionary feature.

6. A new genus *Bhanderia* has a unique ring like body with a large hole. The size of this genus is comparable to *Chuaria dulniensis.* It is not comparable to any known extinct or extant form. Since no internal structure is visible, it is not possible to suggest any taxonomic assignment to this genus. However, if the outer ring of *Chuaria dulniensis* is detached from the inner body, there is every possibility that it will be preserved as *Bhanderia,* as the size range of the outer ring in *Chuaria dulniensis* and size range of *Bhanderia* are comparable. A schematic diagram shows this relationship (fig. 7 – A, B, C and D). Fig. 7-A shows a three dimensionally reconstructed *Chuaria dulniensis*, B- represents *Chuaria dulniensis* , C- *Bhanderia*, which is formed by detachment of the outer peripheral ring seen in *Chuaria dulniensis* and D- represents *Chuaria circularis.* If this relationship is accepted then development of an additional ring in *Chuaria* like

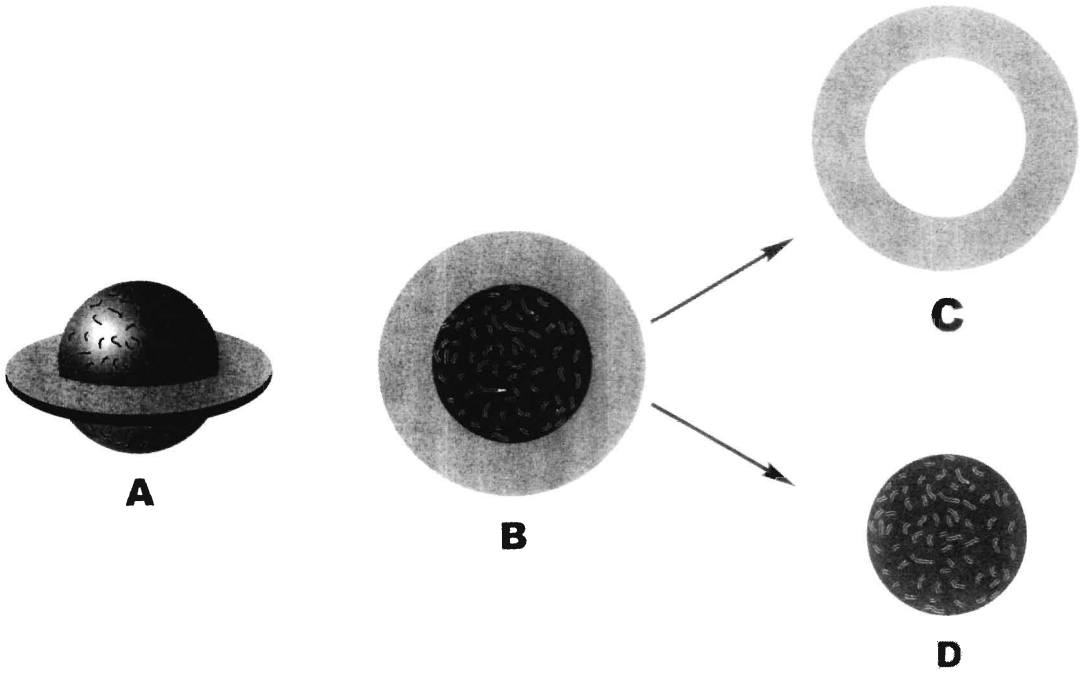

Fig.7. Schematic diagram showing preserved relationship between *Chuaria dulniensis, Chuaria circularis* and *Bhanderia*

A.- Three dimensional reconstruction of *Chuaria dulniensis*. B. *Chuaria dulniensis* as it is preserved on the bedding surface C.- *Bhanderia*. It appears to have been formed when equatorial part of the *Chuaria dulniensis* is detached D.- *Chuaria circularis*. The inner body of *Chuaria dulniensis* is preserved as *Chuaria circularis*.

body can be taken as an evolutionary modification.

7. *Chuaria* may represent different biological entities.
8. A form which gives an impression as a multicellular plant with a hold fast apparatus and thallophytic body enclosing a number of spheroidal bodies has been informally referred as Form A because only two samples have been collected which are counter parts of each other. It has some morphological similarities with Chlorophycean plant.
9. A filamentous Form C shows branching and has much greater width than *Chambalia*. It may have some affinities with filamentous algae.
10. The filamentous form referred to as Form B shows bead-like features at regular interval. No biological interpretation is suggested.
11. Kumar (2001) has described nine megascopic carbonaceous fossils including *Chuaria* – *Tawuia* from the Suket Shale, the uppermost horizon of the Semri Group. In comparison to Suket Shale megafossil assemblage, the Bhander assemblage appears to be much more evolved.

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