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Full Length Research Paper

Record of aquatic carbonaceous metaphytic remains from the Proterozoic Singhora Group of Chhattisgarh Supergroup, India and their significance

Rupendra Babu* and Veeru Kant Singh

Birbal Sahni Institute of Palaeobotany, 53, University Road, Lucknow- 226 007, India.

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For the first time, a rich fossil assemblage of tapic carbonaceous metaphytes referable to eukaryotic algae, preserved on the bedding surface of grey carbonaceous shales belonging to Saraipali Formation of Singhora Group, Chhattisgarh Supergroup, is being recorded in and around Tushgaon village, Mahasamund District, Chhattisgarh state. The present enigmatic bona-fide fossil assemblage includes 12 taxa: *Tuanshanzia fasciaria*, *Tuanshanzia lanceolata*, *Tuanshanzia platyphylla*, *Changechengia stipitata*, *Phascolites imparilis*, *Eopalmaria prinstina, Proterotaenia montana*, *Aggregatosphaera* sp. *Tyrasotaenia podolica* and along with cf. *Chuaria circularis*, *Tawuia dalensis* and broad tubular empty sheath cf. *Siphonophycus solidum* belonging to Cyanophyta, Chlorophyta, Rhodophyta and Phaeophyta algae. Correlation of the present incredible findings (association of multicellularity and extracellular matrix) with earlier known varied type assemblages of biocommunities in well dated Proterozoic sediments represent a testimony to the biotic explosion and diversified fossil carbonaceous plantae records from the terminal Neoproterozoic sediments that could be preserved in such a small window of the latest Palaeoproterozoic and support the advent of multicellularity in algal communities in south of Central Indian Tectonic Zone (CITZ) and indicative of intertidal, marine mid neritic stable shelf, warm environment for the Saraipali sedimentary deposits.

Key words: multicellular, eukaryotes, metaphytes, Saraipali formation, Singhora group, Chhattisgarh supergroup.

INTRODUCTION

After the assembly of 4 blocks (Bundelkhand, Dharwar-an assembly of Bastar, Singbhum and Karnataka craton, Trans Aravalli and Southern India-Srilankan Granulite blocks) of Indian subcontinents along different mobile belts during latest Palaeoproterozoic ca. 1600 Ma (Zhongyuean/Karelian Orogeny) (Shanker et al., 2002), which now occur in several isolated basins such as Vindhyan, Chhattisgarh, Bhima-Kurnool commonly referred to as the “Purana Basins”. These separate basins represent a single large platform domain- the Prototethys (Shanker et al., 2 000) marks beginning of platform sedimentation ca. 1500 Ma. The age assignment of these sediments was earlier based on studies of stromatolites. However, in recent year’s studies on microbiota (acritarchs etc.) and carbonaceous macrofossils occupied the radiometric data from the Vindhyan suggest initiation slightly earlier during early Mesoproterozoic/Late Palaeoproterozoic. The upper age limit of these sediments “oldest platform sequences” is disputed some extend up to ca. 500 Ma or Early Cambrian (Vindhyan) (Azmi, 1998) who earlier terminate it around 750 Ma (Shanker et al., 2000). The age assignment by Azmi (1998) was subsequently discarded by most of workers. Shanker et al. (2000) though did not recognize the Singhora Group considered this assemblage within the time frame ca. 1500-1100 Ma. The Singhora Group has been deformed prior to the

*Corresponding author. E-mail: rupendra_b@yahoo.com
Tel: 0522-2740 008. Fax: 0522-2740 585.

deposition of the overlying Chandarpur Group (Das et al., 2003). It has significant bearing on the contact with the overlying undeformed Chandarpur Group. Post depositional intrusive of doleritic composition are also present as dyke and sill like bodies within the shale-arenite sequence of Singhora and Chandarpur groups. On the basis of SHRIMP U-Pb analysis of Magmatic zircons, that the Sukda rhylotic tuff, near the top succession, Chhuipali Formation may be made. Chhattisgarh basin is the most interesting basin after Vindhyan Basin for the last three decades for biological studies related to enigmatic eukaryotes both micro-macrofossils including prokaryotic in view of the reported informations from the Meso Archaean to end of Proterozoic period since 1899. After first discovery of a mega carbonaceous compression (Walcott, 1854), phenotypic best preserved fossils have been recognized in siltstone (Zhang, 1997) based on published data from the different Proterozoic sedimentaries in few other parts of world-like Africa, Australia, Canada, China, India, Michigan, Montana, Spitsbergen and USA, (Beer, 1919; Walter et al., 1976a; Sahni, 1936; Hofmann, 1977; Hofmann and Jinbiao, 1981; Horodyski, 1982; Amard and Affaton, 1984; Hofmann, 1985a, 1985b; Maithy and Shukla, 1984; Maithy and Babu, 1988; Butterfield et al., 1990; Walter et al., 1990; Grant et al., 1991; Grey and Williams, 1990; Han and Runnegar, 1992; Hofmann and Rainbird, 1994; Butterfield, 1994; Steiner, 1994; Chen et al., 1995; Du et al., 1995; 1986; Yan, 1995; Yan and Liu, 1997, 1998; Rai et al., 1997; Yuan et al., 1999, 2001; Zhang, 1989; 1997; Zhu et al., 2000; Xiao et al., 2002; Rasmussen et al., 2002; Javaux et al., 2004; Rai and Singh, 2006; Xiao and Dong, 2006; Zhang et al., 2006, Singh et al., 2009). The relationship of macrofossils with environments was suggested by few workers (Yan and Liu, 1998; Javaux et al., 2003; Xiao and Dong, 2006; Wang et al., 2008). The microbiogenic origin- organo-sedimentary structures for biostratigraphy (Walter, 1972) including their quantitative and qualitative occurrences with depth of water (Kah et al., 1996) are also studied. The carbonaceous remains are used in biostratigraphy for the Proterozoic stratum (Sun et al., 1986; Hofmann, 1987; Vidal et al., 1993; Du et al., 1995; Yuan et a, 2001; Javaux, 2003) based on quantity and quality of the bioentities (thickness and sizes of the films). The undisputed remarkable carbonaceous megafossils are only known from different horizons belonging to Bhima and Vindhyan basins in peninsular India (Maithy and Shukla, 1984; Maithy and Babu, 1988, 1996; Rai et al., 1997; Rai and Singh, 2006; Singh et al., 2009).

This first finding of epiphytic carbonaceous fossil assemblage in collected samples from the Saraipali Formation has most important significant contributions towards in understanding affinities, age, palaeo-environments and being added new information with earlier known isolated and scanty data from Statherian to Calymmian (1800-1400 Ma) age sedimentaries across the world. It also provides clues towards inter to intra basinal, continental correlations, evolutionary tempo of oxygen and nitrogen concentration in ocean and atmosphere and mode of ancient life with inference of terminal Neoproterozoic and advent of multicellularity in algal communities from the Peninsular India.

LITERATURE REVIEW

The detailed geology and abundant biorelics signatures-stromatolites information were given from the Raipur Group (Sen, 1966; Murti, 1996; Schnitzer, 1971; Jairam and Banerjee, 1980; Jha et al., 1990; Moitra, 1999) in Hirri and Baradwar sub-basins (Chaudhuri et al., 1999; Patranabis et al., 2002); a very few records of palaeobiological evidences representing prokaryotic microfossils both filamentous and coccoides and trace fossils from the two carbonates units: Charmuria and Chandi formations of this Group (Moitra, 1990) till dates. The intersecting Chandarpur Group between the Raipur and Singhora groups is devoid of even remains of plantae. The Singhora Group comprises complex and various lithounits than overlying two groups, had not been investigated by earth scientists in respect of any bioentities except single record of stromatolites – *Conophyton* biostratigraphy marker (Sinha et al., 2001) till the present finding.

GEOLOGICAL BACKGROUND OF THE CHHATTISGARH BASIN

The Precambrian rocks occupied about two thirds of Indian peninsular and substantial part of the Himalayas. The Bastar craton (Radhakrishan, 1987) hosts numerous Meso-Neoproterozoic sedimentaries including Chhattisgarh basin (Naqvi and Roger, 1987) delimited by Pranhita-Godavari Rift and Mahanadi Rift in SSW and NNE. The saucer shaped Chhattisgarh basin (Figure 1) is considered a typical intracratonic and third largest one (Das et al., 1992) amongst Purana basins (Holland, 1906), falls south of CITZ (Yedekar et al., 1990) and occupies an area ~35000 sq. km. in the central part of the Indian Peninsula (Kale and Phansalkar, 1991). This basin is bounded to the west by the north-south trending Kotri Volcanics and Chilpi Group rocks, to the northeast and by Eastern Ghat Mobile belt in southeast. Tectonically least disturbed, unmetamorphosed, mildly deformed rocks of the Chhattisgarh Supergroup extensively developed and widely distributed in south central part of Chhattisgarh (Murti, 1987) and its adjoining parts viz. Barapahar, located in western part of the Bargarh district in Orissa (Das et al., 2003), dominantly arenaceous and argillaceous amongst sedimentaries of Chhattisgarh Supergroup (Murti, 1987; Prajapati et al., 2004). All lithounits are classified into three successive groups

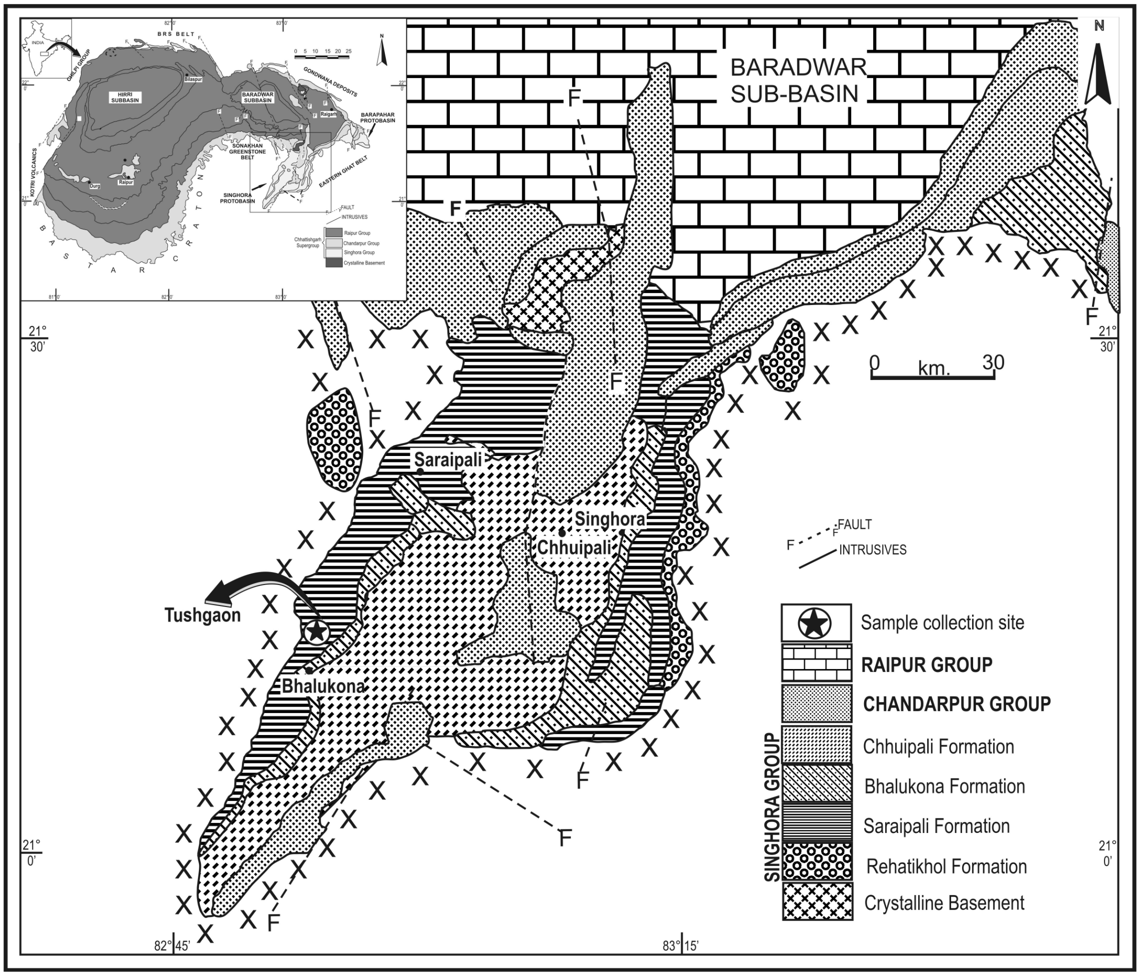

Figure 1. Generalized geological map of the Singhora Protobasin (modify after Das et al., 1992), fossil horizon is marked by a star.

namely the Singhora, Chandarpur and Raipur and subdivided into various formations (Dutt, 1964; Murti, 1987; Schnitzer, 1971; Pascoe, 1973; Das et al., 1992; Sinha et al., 1998; Chaudhuri et al., 1999). The sedimentaries (~ 3000 m thick) are well exposed in two separated sub-basins: 1) Hirri Sub-basin in West, 2) Baradwar Sub-basin in East (Das et al., 1992) of the Chhattisgarh basin. These lithounits unconformably rests over the Archaean to Palaeoproterozoic crystalline basement of Bastar craton and Sonakhan Greenstone belt (Pandey et al., 1995) in the south as well as Lower Proterozoic metamorphites of Satpura belt in the north. Intensive folds and faults are noticed in eastern part of the basin especially in Barapahar region coeval some what to Singhora Protobasin.

Geological setup of the Singhora Protobasin

A small embryonic Protobasin named as Singhora Protobasin after Singhora town, consists 400 m thick sedimentary deposits in southeastern part of Chhattisgarh basin. The rocks are tectonically least disturbed, unmetamorphosed, mildly deformed comprising different litho-units viz. arenaceous, argillaceous and carbonates are extensively developed and widely distributed in extreme south end of Baradwar subbasin in Chhattisgarh. It is confined an oldest stratigraphic sequence as Singhora Group subdivided into four successive formations namely Rehatikhol, Saraipali, Bhalukona and Chhuipali (Table 1) after painstaking efforts by pioneer geologists (Murti 1987; Das et al., 1992, 2003; Sinha et al., 1998). Equivalent sediments seen more folded and faulted in south eastern end of Chhattisgarh Basin (Pascoe, 1973) constituting twelve hillocks named as Barapahar overlie the basement rocks viz. Sambhalpur Granitoids in Orissa state (Chaudhuri et al., 1996). The general strike of the formations is NE-SW with dips (5-10°) towards NW. The fossiliferous materials used in present study, collected from the one lithounit–Saraipali Formation (60 m thick) characterized by a litho-assemblage-finely laminated variegated shale with

Table 1. Generalized Stratigraphic chart of the Singhora protobasin, Chhattisgarh supergroup (after Murti, 1987, Das et al., 2003). (☼Showing the position of fossiliferous unit)

Group	Formation	Lithology
Chandarpur	Intrusives	Basic dykes
	Kansapathar (200 m)	Medium grained quartz arenite
	Chaporadih (200 m)	Dark and light grey shale siltstone with quartz arenite, feldspathic arenite
	Lohardih (20 m)	Greenish grey, arkosic and wacky arenite with basal conglomerate/ferruginous sandstone-Shale and grey chert
	——Ω——Ω—— Ω—— Ω—— Ω——Disconformity ——Ω——Ω——Ω——Ω——	
Singhora	Chhuipali (~300 m)	purple shale with stromatolitic limestone, fine arenite and chert intercalation
	Bhalukona (20 m +)	Quartz arenite and glauconitic quartz arenite with Porcellanite
	Saraipali☼ (100 m)	Variegated shale with fine arenite, carbonate and Porcellanite member
	Rehatikhol (60 m)	Basal Conglomerate/arkose, feldspathic arenite and quartz arenite
	^^Unconformity^^^	
	Basement	Granite gneiss and supracrustals

Table 2. Generalized Chronostratigraphic chart of the Chhattisgarh Supergroup based on available data.

Group	Formation	Lithology	Age
Raipur		Limestones, dolomites and shales	1000-900 Ma (Deb et al., 2007) ? 518 Ma (Naqvi, 2005)
Chandarpur		Sandstones and shales	~ 1650 Ma (Deb et al., 2007) 1000 Ma (Naqvi, 2005) 1600 Ma (Shankar et al., 2000)
	^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^Unconformity^^^		
Singhora	Chhuipali (300 m)	Stromatolitic limestones, dolomites, chert, siltstone and variegated shale	Late Riphean (Das et al., 2001)
	Bhalukona (20 m+)	Quartz arenite, siltstones, porcellanite and shales	1500 Ma (Das et al., 2009)
	Saraipali (60 m)	Variegated shales with siltstone, chert and minor limestone	
	Rehatikhol (20 m+)	Feldspathic arenite, and Conglomerate	Lower Riphean (Sinha et al., 2001)
Sonakhan		Granitic basement	2500-2300 Ma (Chaudhuri et al., 1996; Pandey et al., 1995)

minor siltstone, laminated Porcellanite and limestone as pockets (Das et al., 1992). The similar lithologies are found in two formations viz. Tushgaon (Dutta et al., 1989); Rehatikhol of the oldest group (Singhora) and youngest Formation- Tarenga of Raipur Group (Sinha etal., 1998) based on the segmental detailed geological information northern and southern part of the Chhattisgarh Basin.

Age calibration

The assigned age for different groups in Chhattisgarh Supergroup ranges 1800-550 Ma (Table 2) overlie the crystalline basement represents granitoids of Sambalpur age: viz. Siderian- 2500-2300 Ma (Pandey et al., 1995; Chaudhuri et al., 1996) and calibrated by pioneer workers based on different aspects like geology and its allied disciplines (geochronological, palaeomagnetic, petrology), isotopes as well as little biological remnants information. Rarity and poor reliability of radiometric dates for age preclude any possibility of constraining the time span for the Chhattisgarh succession except southeastern part. Raipur Group which confined two carbonate sequence viz. Charmuria Limestone Formation is the oldest carbonate sequence considered equivalentto Semri Group, lower Vindhyan (Dutt, 1964) and Chandi Limestone Formation representing upper carbonate is equivalent to Lower Bhander Limestone Formation of Bhander Group (Jairam and Banerjee, 1980) and also earlier viewed (King 1877; Medlicott, 1885) before 1992. Sedimentaries like Saraipali Formation is additional not occurred in Lower part of the Semri Group in Vindhyans. The available information in assigning age of the Chhattisgarh basin is now fluctuating like Vindhyan Supergroup (summarized Rasmussen et al., 2002) due to inconsistence radiometric dates and sparse of palaeobiological evidences (Murti, 1987; Moitra, 1990; Banerjee and Mazumdar, 1999; Moitra, 1999; Naqvi 2005). The entire succession of Raipur Group has been opined between middle Riphean to Vendian ca. 1100-800 Ma (Schnitzer, 1971; Moitra, 1999; Murti, 1978b); 750-650 Ma age of the Lower Bhander Group correlated with upper part of Raipur group based on Pb-Pb methods (Chakraborty, 1997) and 1721 ± 90 Ma for the Kajrahat Formation of Semri Group (Sarangi et al., 2004) as well as 1200 Ma for lowermost lithounits viz. Gundardehi shale of this group by palaeomagnetic dates (Verma et al., 1977). U-Pb SHRIMP ages of Zircon grains is from the stratified ignimbrite layer in the topmost Sukda volcanic tuffs in Churtela Shale of Raipur Group <1000 Ma (Patranabis et al., 2007) rather than uppermost geological units of Raipur ~518 Ma (Naqvi, 2005) including refuting earlier views as Meso/Neoproterozoic boundary (Chaudhuri et al., 2002) based on the Kimberlite and similar lithounit containing Porcellanite in basal part of the Semri Group dates 1599±8-1628±5 Ma (Rasmussen et al., 2002). Similar sediments found in oldest formation of Singhora and its contemporaneous Khariar basin is dated 1500 Ma by geochemical studies (Das et al., 2009). An estimated age viz. ca. 699 and 753 Ma for the Chaporadih Formation of the Chandarpur Group overlie the Singhora Group age is based on by single K-Ar isotope dating of authegenic glauconite mineral (Kruezer et al., 1977); early Neoproterozoic by petrochemistry for mildly matured sandstone (Datta, 2005) and similar sediment- Panna kimberlite of Kaimur group dated 1073±13.7 Ma in age (Gregory et al., 2006). Later, the given dates for top part of Raipur Group (Patranabis-Deb et al., 2007) have been questioned after drill core Ignimbrite samples studies (Mukherjee and Ray, 2008, Basu et al., 2008). The age of Chhattisgarh Supergroup considered earliest Mesoproterozoic-Neoproterozoic end (1600-630 Ma) based on palaeobiological data published from the different Precambrian sequences of Peninsular India by various earth scientists (Shanker et al., 2000) and also contemporaneous information from China, Africa, Australia and India. Das et al. (2001) has also summarized all the isolated and detailed studies done by various workers on various disciplines and suggested 1800-1600 Ma age for the Singhora Group, simultaneously Lower Riphean age for the Rehatikhol Formation Singhora Group (Sinha et al., 2001) based on morphology of stromatolites as discussed for biostratigraphic significance (Walter, 1972), sedimentological studies (Chakraborty et al., 2009). The Porcellanite is non clastic found in basal part of the Rehatikhol Formation and its enormous source might be radioelement- Uranium, as a prophase felsic magmatism during early Proterozoic 1900 Ma while their reactivation possibly genesis through episodically in 1600-900 Ma (Gandhi, 1995). The 2nd stage of Uranium mineral amongst the identified through the ages, has been recorded at the level of middle Proterozoic basal close to unconformity with lower Proterozoic sediments has been analysed the published reports from the Athbaska, Saskachwan Canada, Alligator rivers, Pine Creek field geosynclines Australia and Lambapur, Mahasamund areas India (Sinha et al., 1998). Presence of palaeo-weathering profile and Sulphur isotope studies (Sinha et al., 1998) from the oldest formation viz. Rehatikhol, of Singhora Group, indicate a major environmental shift that is also earlier reported from 2200-1900 Ma ago.

Depositional environment

The central Indian craton in peninsular India conferred Chhattisgarh basin among four distinct mosaic blocks in Indian Precambrian and reveals complex tectonic setups based on the four type's sedimentation surround it (Das et al., 1992); transgression to tectothermal activity (Shanker et al., 2000). The various type studies- sedimentology, petrology, geochemistry and biorelics have mostly been carried out to deduce depositional environs for each formation of Raipur and Chandarpur groups belongs to Hirri and Baradwar sub-basins upto recognizing Singhora Protobasin before 1992. The variable environments are represented by tidal flat (subtidal-intertidal) based on the stromatolites and few reports of microfossils in Chandi Formation (Jairam and Banerjee, 1980; Murti, 1987; Moitra 1995); regression phase to Charmuria Formation in presence of glauconite mineral (Dutta et al., 1989). Where as 11 facies of Chandarpur Group overlies the Singhora Group shows regression and deposited in shelf shore face, foreshore, beach, tidal eustuary and delta condition (Chakraborty and Paul, 2008); regression-transgression (Chaudhari et al., 1999); episodic regional thrusting and sea level changes (Patranabis-Deb et al., 2002; Patranabis-Deb, 2004); Deltaic semi-arid based on the petrochemistry (Datta, 2005); low aeromagnetic effects in south eastern part of the basin (Ram et al., 2007).

The Singhora Protobasin representing variable depositional environments based on the geology followed by field visits, aeromagnetic analysis and laboratory studies. The geomorphology of the area (Das et al., 1992) is here corroborated the sagging and desiccating nature for the basinal analysis based on the identical lithofacies (Allen and Allen, 1990). High anomalies rather than north region in the basin have been recorded (Ram et al., 2007, Chaudhuri et al., 1996); intracratonic sag setting as inter fan for peripheral and marine fan for central part (Das et al., 1992) of its four formational units representing repetition of regression and transgression phase (recycling) based on the lithologies and minerals- porcellanites and Uranium (Das et al., 1992; Sinha et al., 1998; Chakraborti, 1997; Gupta, 1998) for Rehatikhol. Later, each formation of the Singhora Group has distinct depositional environment like shallow marine, oscillatory environment and intertidal-supratidal zone (Bhairam et al., 2000); shallow shelf offshore under stable platform for Saraipali (Das et al., 1992; Gupta, 1998; Chakraborty et al., 2009); regressive phase (coastal zone) for Bhalukona Formation based on the presence of authegenic glauconite mineral; first shallow marine transgression for the top Chhuipali Formation of this group (Chakraborti, 1997).

The Rehatikhol formation is deposited in high energy and complex fan-braid-plane and delta setting representing oscillating condition: intertidal to supratidal (Chakraborty et al., 2009; Sinha et al., 1998) and also for identical sediments (Eriksson et al., 1995). Volcanic tuffaceous rocks are chert and porcellanites formed by natural heat creating substances like sulfur, hydrogen and radioelement for source of energy through geothermal activities underneath. The radioelements are mostly found at fault zone (Kale, 1995) and >5 ppm Uranium (Sinha et al., 1998) in underlie the present formation. Out of 400 m, 100 m thick sedimentaries substratum represent three formations from basal to up in Singhora Group indicate marginal/tectonic zones of Chhattisgarh Basin. Regional tectonic factors can also affect the climate (Eyles, 1993). Similar setting of basin is as given for the Palaeoproterozoic period (Schneider et al., 2002; Noffke et al., 2006; Janhunen et al., 2007). Uranium isotopes would be changed by environment through the age. The proliferation of the present assemblage might be hyper-thermopile water condition due to volcanic and geothermal environment possibly by radioactive elements, dissolved appreciated amount nutrients with macro-biomolecules. Signature of snowball Earth" is not seen here as described for Diamictites Iava ca. 2222 ± 41 Ma (Cornell et al., 1996), which recorded from the Cryogenian sediments of Krol belt in Lesser Himalaya. This condition is mainly recorded along terrestrial and submarine to tectonic fracture zone. The fossil bearing strata in Saraipali Formation are interpreted here moderate deep deposited in relative deep water below the wave base (mid neritic) represents warm, quiet lagoonal (spring tide) protected embayment and low energy settings.

MATERIALS AND METHODS

The grey shale samples were collected and dug them to be chisel out chips (2-20 cm) along the bedding planes from the middle part of Saraipali Formation exposed and at Surangi Nadi section near Tushgaon village (Lat. 21° 14' 51.3" N: Long. 82° 56' 39.0" E) located 2.5 kilometer south of Saraipali block (Figure 1) in Mahasamund district, Chhattisgarh. The river flowing over the positioning in middle of shale deposits in Saraipali formation are both sides on the river embankments near bridge. The exposure of the shale is vertically, 2-3 m (Figure 2) and dipping gently towards SE direction. 200 fossiliferous fine silty shale samples were collected an approximately 0.5 m interval from the 3 levels of the succession start near the base of the Saraipali formation. The fossil assemblage contains heavily biomass of varied morphologies, shape and sizes characterizing three types -coccoidal, filamentous and leafy nature.

Individual chipping small fragments from different parts of the slab were carefully examined under a binocular microscope to be free of alteration, veining and secondary calcite. Dressed chips are initially gently broken into smaller fragments (1–3 mm) for ease of dissolution. But later a single fragment (4–5 mm) was used to minimize surface contamination from handling and to remove any loosely adhering fine soil particles through distilled water and dried them for final studies. The morphologies of the fossil assemblage and their internal features recovered in macerated residues are studied in details under Wild Heerbrugg low power M8 and BH2 Olympus high power microscopes; and photographed of these on software supported Leica DFC290 digital camera. The repository of the figured specimens is available at museum of the Birbal Sahni Institute of Palaeobotany, Lucknow (Statement no. BSIP 1261), India.

MEGASCOPIC CARBONACEOUS BIOREMAINS PRESERVATIONS

Morphologically, without curved and enrolled margin of 12 distinct taxa including *Chuaria* and *Tawuia* mass (bloom) of metaphytic algae fossils are meso-megascopic (few millimeters to centimeter) tapic carbonaceous compressions and impressions (Plates 1 and 2). They are entombed and preserved on the bedding planes in collected shales, represented by vegetative thallus of varied shapes like flat, flexible (easily corrugated), discoidal, leaf like carbonaceous film with/without holdfast at base, palmate, elongated, algal thallus including multicellular? reproductive structures that are solitary, entangled and bunch of long cylindrical twisted/folded fine filaments representing Cyanophyta, Chlorophyta, Rhodophyta and Phaeophyta algae confined by palaeobiologists with modern knowledge of biology. The description of fossils is only possible rather than taxonomic position due to lacking of distinct features and poor preservations. The detailed description of the each taxon is given in the text and figure (Plates 1 and 2) based on hold fast, branching and thalli nature. The counts provide a population census (Figure 3) is actually alive on the sea floor not more than 100 m in depth. The anatomical features are not easily accessible due to carbonization during fossilization and the multicellularity which can be seen in macerated residue in presence of fragmentary forms. The microbial remains study is under progress.

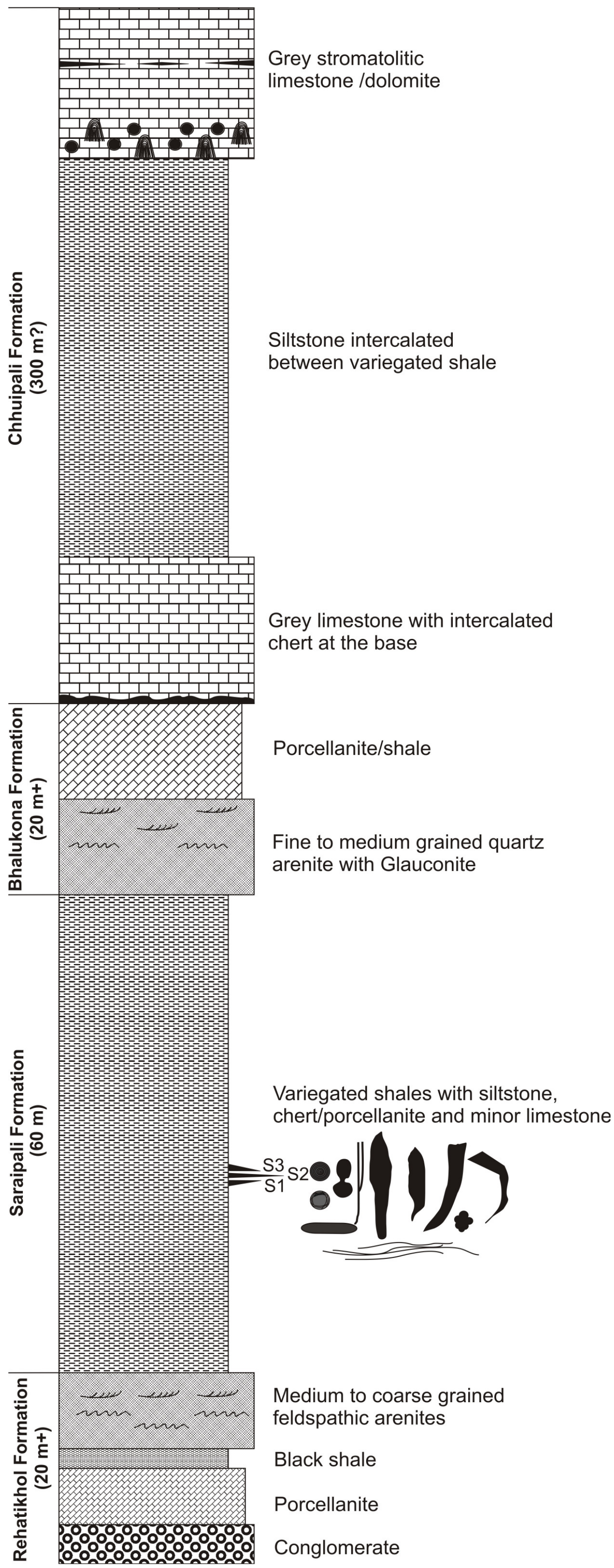

Figure 2. Lithostratigraphic column of the Singhora group (after Das et al., 1992) showing the levels of fossils bearing shale.

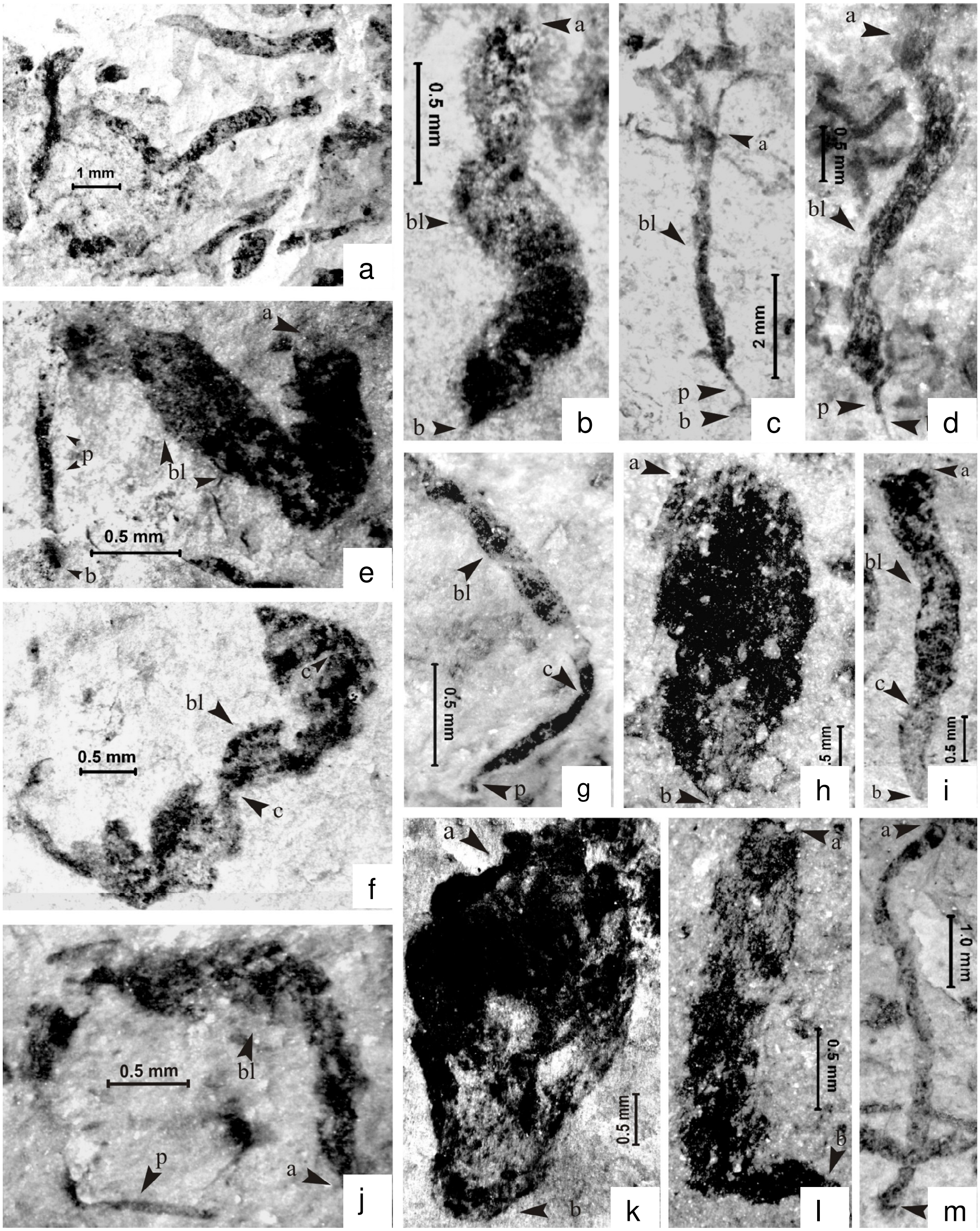

Plate 1. (a). Overview of carbonaceous biomass bearing shale (BSIP-39782). b). *Tuanshanzia lanceolata* (BSIP- 39769). (c). *Changchengia stipitata* (BSIP-39781). (d). *Changchengia stipitata* (BSIP-39777). (e). *Changchengia stipitata* (BSIP-39782). (f). *Tuanshanzia fasciaria* (BSIP-39770). (g). *Changchengia stipitata* (BSIP-39776). (h). *Eopalmaria pristina* (BSIP-39778). (i). *Tuanshanzia lanceolata* (BSIP-39773). (j). *Changchengia stipitata* (BSIP-39779). (k). *Eopalmaria pristina* (BSIP-39779). (l). *Eopalmaria pristina* (BSIP-39774). (m). *Tuanshanzia fasciaria* (BSIP-39780). (a- apex; b – base; bl- blade; c- constrictions; p- parastem).

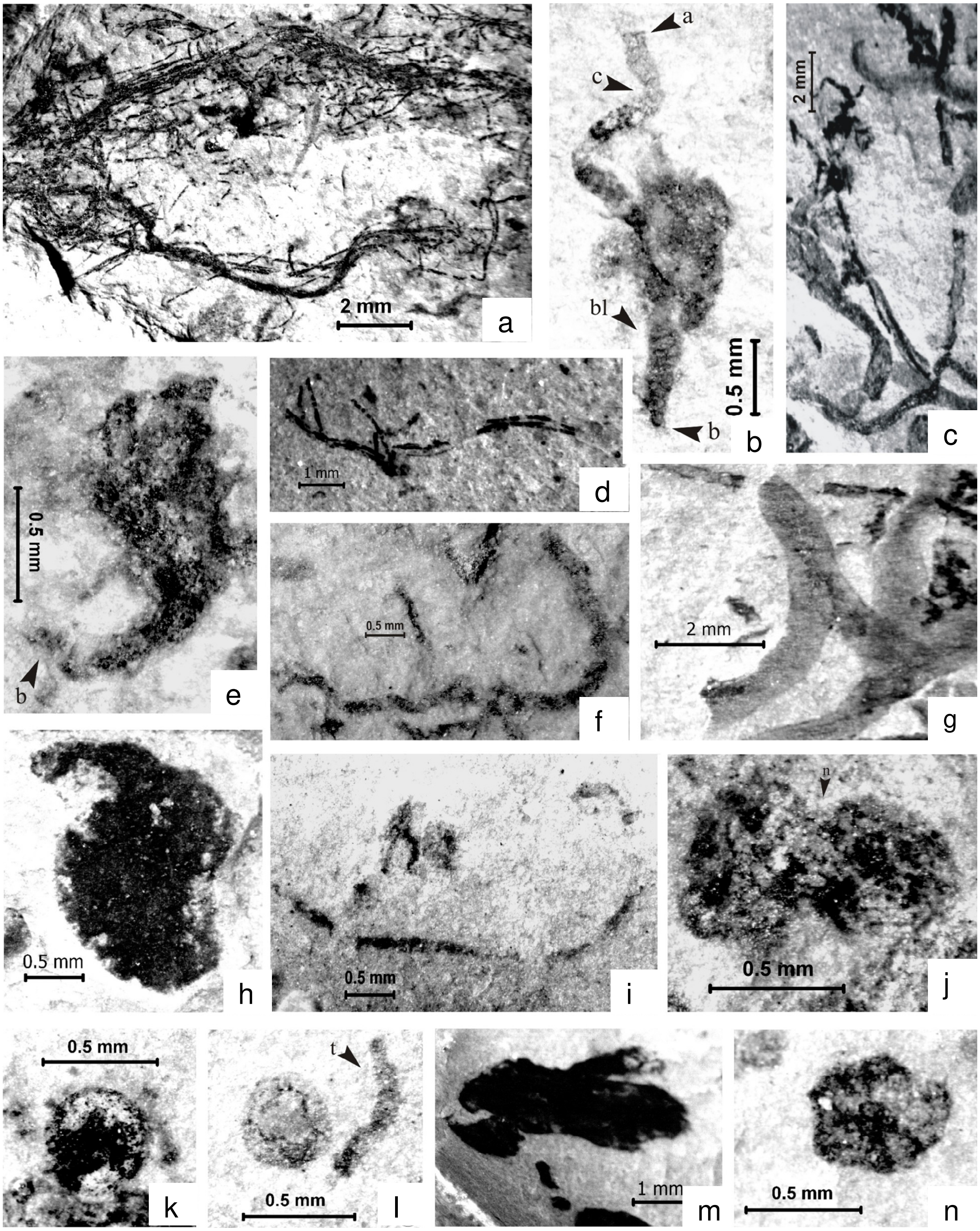

Plate 2. (a). *Proterotaenia montana* (BSIP-39775). (b). *Tuanshanzia fasciaria* (BSIP-39769). (c). *Tuanshanzia fasciaria* (BSIP-39771). (d). *Proterotaenia montana* (BSIP-39772). (e). *Tuanshanzia platyphylla* (BSIP-39777). (f). *Tyrasotaenia podolica* (BSIP-39780). (g). Smooth walled cylindrical thallus cf. *Siphonophycus solidum*. (BSIP-39775). (h). *Phascolites imparilis* (BSIP-39773). (i). *Tyrasotaenia podolica* (BSIP-39769). (j). *Phascolites imparilis* (BSIP-39782). (k). *Chuaria circularis* (BSIP-39782). (l).*Chuaria circularis* (cf. *Leiosphaeridia*) associated with cf.*Tawuia dalensis* (BSIP-39769). (m). cf *Tawuia dalensis* (BSIP-39773). (n). *Aggregatosphaera* sp. (BSIP-39782). (a- apex; b – base; bl- blade; c- constrictions; p- parastem).

DESCRIPTION OF FOSSILS

a) Genus: TUANSHANZIA (Yan, 1995).

i. *Tuanshanzia fasciaria* (Yan) Yan and Liu, 1997 (Plate 1f and m; Plate 2b and c).
Description: specimens-ribbon like algal thalli, measuring 4.0 to 18.5 mm in length and 0.4 to 0.5 mm in width, unbranched, lanceolate, clavate or taeniate, with or without rounded apex, unequal in width, base narrow, slightly tapering towards base, parastem absent, margins smooth, rhizoidal protuberances often seen, longitudinal striate, simply visible on surface of blade, less folded and twisted thalli.

The present taxon comprises akin morphology and smaller than known from the Changcheng system (1700-1400 Ma) of Tuanshanzi formation (Yan and Liu, 1997) and Yanshan basin (Yan and Liu, 1998) in Jinxian, Hubei of China.

ii. *Tuanshanzia lanceolata* Yan, 1995 (Plate 1b and i).
Description: specimens- simple algal thalli, measuring 1.0 to 6.0 mm in length and 0.3 to 0.5 mm in width, lanceolate, thick, narrowing and tapering towards both the ends and is widest in the middle part with even margins, moderately folded, parastem absent and with rhizoidal protuberances.

The present form is morphologically agreed with known form from the 1,700 Ma old sediments (Yan, 1995) and smaller than known from the Changcheng system ranging 1700-1400 Ma sediments (Yan, 1995; Yan and Liu, 1997, 1998) belonging to Tuanshanzi Formation and Yanshan basin in Jinxian, Hubei of China.

iii. *Tuanshanzia platyphylla* (Yan) Yan and Liu, 1997 (Plate 2e).
Description: specimens-leaf like thallus, measuring 2.0 mm in length and 0.6 mm in width, simple sessile, latifoliate, irregular, oval to oblong with rounded apex and contracted base; short thick stalk projection at base and preservation in one direction.

The present form is morphologically agreed with known form from the 1700 Ma sediments belonging to Tuanshanzi Formation in Jixian, Hebei (Yan, 1995). The *Tuanshanzia* genus differs from the *Chanchengia* in lacking of stalk like para-stem and Eopalmaria due to smooth rounded apex. Thallus morphology of the recovered taxa *Tuanshanzia* can be compared to *Patalonia* of Phaeophyta. The present specimens are differed from the *Longfengshania stipitata* Du consisting long, thin, elongate seta like structures.

b) Genus: CHANGECHENGIA (Yan and Liu, 1997).

Changechengia stipitata Yan and Liu, 1997 (Plate 1c-e, g and j).
Description: specimens- blade like thalli, measuring 3.0 to 40 mm in length and 0.5 to 3.5 mm in width, broad ribbon like or lanceolate, unbranched, in equilateral, widest at middle, tapering towards the apex, and narrowing towards base, base obtuse, contacting with long parastem, contact transitional between parastem and blade, folded, lamellose margins with slightly ruffled surface towards the base, parastem linear and projected at base of thalli.

Present taxon morphology is akin to earlier recorded form *Tuanshanzia stipitata* from the sediments (1700 Ma) of Tuanshanzi Formation of China (Yan 1995) which later described under the *Chanchengia stipitata* based on the emended diagnosis of the taxa *Tuanshanzia* (Yan and Liu, 1997). The akin taxon is smaller than known from the Changcheng system (1700-1400 Ma) of Yanshan Basin (Yan and Liu, 1998) in Jinxian, Hubei of China.

c) Genus: PHASCOLITES (Duan et al. 1985).

Phascolites imparilis (Duan et al., 1985; Du, 1995) (Plate 2h and j).
Description: specimens- pod like carbonaceous compression, outline comprised of two rounded sacci, connected each other by a cylindrical tubiform structure, bigger at one end and smaller at other end, measuring larger saccus 0.4 to 2.0 mm and smaller are 0.2 to 0.3 mm in diameters, cylindrical tubes 0.1 to 0.55 mm long and 0.3 mm wide.

The present form is totally resembled in morphology with known taxa *Phascolites imparilis* (Duan et al., 1985) from the China (Du, 1995) and does not agrees with the known species of *Longfengshania stipitata* Du in absence of two saccus bearing in common a pod like structures. This taxon considered as detached female reproductive structures belonging to laminariales order of Phaeophyta.

d) Genus: TYRASOTAENIA (Gnilovaskaja, 1971).

Tyrasotaenia podolica Gnilovaskaja, 1971 (Plate 2f and i).
Description: filaments, measuring 4 – 7 mm length and 0.1 to 0.3 mm width, generally solitary tubular compressions of curved/twisted, more or less parallel and body margins, occasionally folded, smooth, some times constriction on body.

This genus confining Phaeophyta affinities is reported for the first time from the fine grained clastic sediments of 900 Ma from the Russian platform (Gnilovaskaya, 1971), later from the 1300 Ma old sediments of Belt Supergroup, Montana (Walter et al., 1976), Little Dal Group, Mackenzie Mountains, northwestern Canada (Hofmann and Aitkin, 1979), also between1900 1700 Ma near Jixian, northern China (Hofmann and Jinbiao, 1981) having slightly lesser width than the present form. Akin taxon *Quanshania mgnifica* Yan from the Changcheng period (1800-1400 Ma) sediments of Yanshan Basin in Jixian, northern China (Yan and Liu, 1998) having less width than present form. Previously the affinities of this

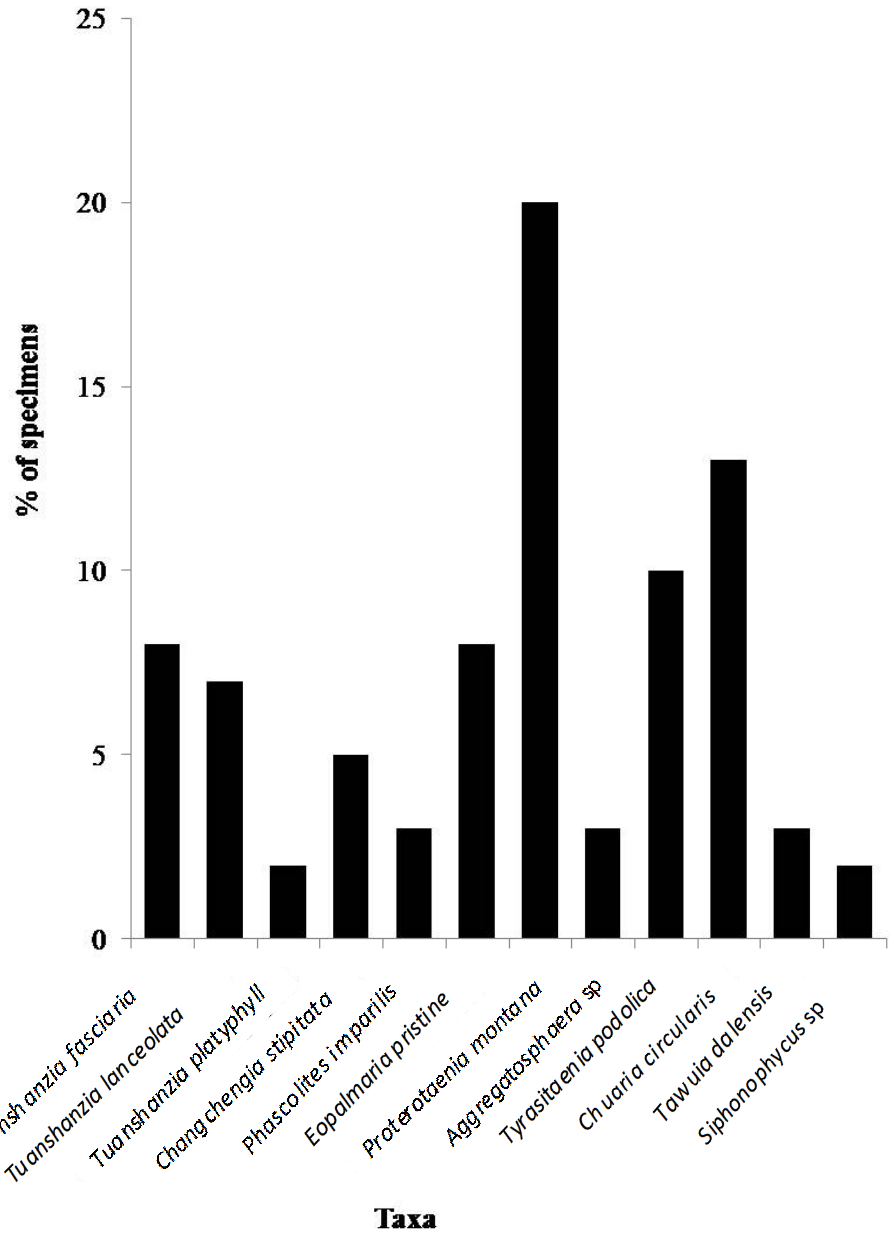

Figure 3. Frequency distribution chart of Carbonaceous macroscopic remains.

taxon considered as Phaeophyta.

e) Genus: PROTEROTAENIA (Walter et al., 1976).
Proterotaenia montana Walter et al., 1976.(Plate 2a and d).
Description: specimens- filaments, thin, measuring 7.0 – 20 mm long and 0.1 to 0.25 mm thick, unbranched, curved or winding; more or less straight, cluster sometime solitary single, arranged in bunches.

The present form is most similar in morphology with the form described from Changcheng Formation (1800 Ma) of Jixian, China (Yan and Liu, 1997) and annelid like structures described under *Helminthoaichnites* Walcott from the 1300 Ma old sediments of Belt Supergroup (Walter et al., 1976), from the Gaoyuzhang Formation sediments (1400 Ma) of Jixian, China (Yan and Liu, 1998). It does not compare with known taxa of prokaryotes without containing carbonaceous matter reported from the Proterozoic sequences world over. The affinities of such type forms are earlier considered two divisions of the algae: a. Phaeophyta-*Chorda* and *Scytosiphon* taxa; b. Rhodophyta-Nemalion forms and finally placed it in Phaeophyta (Yan and Liu, 1997). Without essential affinities like clitellum and setae (Sun et al., 1986) with proboscis of annelids as described earlier is considered as eukaryotic algae.

f) Genus: EOPALMARIA (Yan, 1995).

Eopalmaria prinstina Yan, 1995 (Plate 1h, k and l).

Description: specimens- algal thalli, elongate, flat sheet like blades with tiny crust, foliate, net features looking as pseudo-parenchyma, multiaxial, apical rounded, base sometime appearing stalk like projection, angular to sub rounded at base, measuring 2 to 4 mm length and width 1.25 to 1.50 mm in middle,

Akin taxon is smaller than known from the Changcheng system (1700-1400 Ma) of Tuanshanzi Formation (Yan, 1995) and Yanshan basin (Yan and Liu, 1998) in Jinxian, Hubei of China. Fossils are most comparable to modern *Rhodomenia* of the Rhodophyta rather than *Monstroma* of Chlorophyta (Rai and Singh, 2006) and *Spathoglossum* of the Phaeophyta (Yan and Liu, 1997).

g) Genus: CHUARIA (Walcott) (Vidal and Ford, 1985).

Chuaria circularis (Walcott) Vidal and Ford, 1985 (Plate 2k and l).

Description: specimens- carbonaceous compression and impressions of two dimensionally flattened preservation , opaque, 0.5 to 1.0 mm, circular to elliptical with indistinct periphery folds.

The present forms are morphologically similar to the oldest known single layer *Chuaria circularis* from the China of 1800 Ma (Zhu et al., 2000) and smaller than Mesoproterozoic to ediacaran period recoded from the Indian subcontinents and other parts of the world (reference in the part of discussion). The affinities of its suggested Chlorophyta (Steiner, 1994), Cyanophyta-aggregation of cells (Walter et al., 1976; Yuan et al., 2001), probably allied to primitive alga (Du Rulin et al., 1986), algae (Grey and Williams, 1990), colonies of nostocaceae filamentous based on the extant genus – *Nostoc* (Sun, 1987), eukaryotic signature-sphaeromorphs acritarch impressions (Ford and Breed, 1973; Hofmann, 1977, 1992; Maithy and Shukla, 1984; Amard and Affaton, 1984; Zhang, 1997); chlorophycean affinity of acritarchs (Arouri, et al., 1999); spherical plankton organism (Gussow, 1973); algal cyst (Vidal, 1976; Jux, 1977) and eukaryotic phyto signatures- n-alkanes/n alkenes doublets through gas chromatography (Dutta 2006); steranes (Summon and Walter, 1990; Lamb et al., 2007). Varied types scattered carbonaceous impressions and compression-non fossil to trace fossils described by various workers under different names which grouped/named in *Chuaria* basing on dominancy in finding from the two horizon of Belt Supergroup in Montana belonging to Calymian age (Walcott, 1899),- scattered beaded (Horodyski, 1982; Maithy and Shukla, 1984; Grey and Williams, 1990); string beaded/chain *Horodyskia* Fedonkin and Yochelson oldest tissue grading of lower invertebrates as non calcified micro-sponge (Fedonkin and Yochelson, 2002; Hofmann, 1992; Javaux et al., 2003), enigmatic beaded and pseudo-fossils for the 2000 Ma old sediments of China (Lamb et al., 2007).

h) Genus: TAWUIA Hofmann and Aitkin, 1979.

Cf. Tawuia dalensis Hofmann and Aitkin, 1979 (Plate 2l and m).

Description: specimens- sausage to ribbon shaped, compression, with more or less parallel sides, sub-rounded both ends, marginal folding absent, measuring 1 to 2 mm length, upto 0.4 mm, wall thin.

The present ribbon like compression is also recoded from the Statherian to younger strata of Proterozoic in various part of world like Canada, China, Svalbard Russia including India (references in Singh et al., 2009). The affinities of this taxon are recognized as algae belonging to Phaeophyta algae (Hofmann, 1981, 1992) and Chlorophyta (Zang and Walter, 1992) and metazoan for *Sinosabellidites* as worm like organism (Hofmann 1985; Sun et al., 1986) and lower metazoan (Fedonkin and Yochelson, 2002; Hofmann, 1994). It is smaller than the known *Tawuia* from the Ectasinian sediments of different part of the world and always found in association of C*huaria* which considered a part of life cycle (Maithy and Babu, 2005) of any advance group of algae possibly Chlorophyta nearer to prokaryotes against the reported earlier various carbonaceous taxa compare with Xanthophyta, Chlorophyta and Phaeophyta from the Precambrian sediments in Vindhyans in India till 2005. *Chuaria* and *Tawuia* were closely related and compared them with the green alga *Ulva lacluca* and U. *rigida*, as *Ulva* in its reproductive stage can produce both sphaeroidal and elongated forms similar to *Chuaria* and *Tawuia* but *Ulva* is much thinner and cellular (Zang and Walter, 1992).

i) Genus: AGGREGATOSPHAERA (Xiao, Yuan, Steiner, Knoll, 2002).

***Aggregatosphaera* sp.** (Plate 2n).

Description: specimens- two dimensionally preserved, vesicle like, circular in shape, thin walled, measuring 0.3 to 0.5 mm, each specimen containing tightly packed 4-8– coccoidal cells without flagella, measuring 0.1-0.2 mm.

The present form based on its surface preservation is morphologically similar to the described earlier silicified taxa- *Paratetraphycus, Tetraphycus, Glenobotrydion, Sphaerophycus,Myxococcoides*, *Phanerosphaerops* of chroococales from the Proterozoic sequences of countries like China, Australia, Canada Greenland and Spitsbergen. The preservation and smaller size morphology in present recorded forms from the Saraipali Formation does not favor with the known form *Aggregatosphaera miaohensis* (Xiao et al., 2002) of Upper Sinian Doushantuo Formation and placed this taxon in a eukaryotic alga based on morphological characters. It does not tally with diagnosis of genus *Chuaria* due to the absence of wrinkles, folding and unusual preservation as external mold, cyanobacterial envelopes or acritarch walls. These forms seemingly endospores might be a developmental stage of zygote in life cycle of any advance algae described from the Bhima basin (Maithy and Babu, 2005). The affinity of *Glenobotrydion* genus is still unresolved problem inclusion of solid dark black in body so called nuclear material and considered as Chlorophyta based on the pyrinoid like structures (Schopf, 1968), shrinkage of the cytoplasm due to exo-osmosis (Golubic, 1980) and mineralic filling (Oehler, 1977) in cells of Cyanophyta. However, authors are opined that the coccoides containing black body representing digenesis changes in chlorophyll b bearing algae-possible prochloron (Lewin, 1976) between Chlorophyta and Cyanophyta (Lee, 1980). The genus affinity considered as coenocytic green algae (Xiao et al., 2002).

j) Genus: SIPHONOPHYCUS (Schopf, 1968)
Enigmatic filaments cf. Siphonophycus solidum *(*Golubic) Butterfield et al., 1994 (Plate 2g).
Description: specimens- two dimensionally carbonaceous compression, unbranched, smooth cylindrical tubes, measuring 11.0 mm length and 1 mm width. This form is larger than the known *Siphonophycus solidum* Golubic from the Mesoproterozoic sediments and might be formed decaying of the internal organic matter as Chlorophyta. Similar structures are of sheath and considered as vendotaenids represent higher algae recorded mostly from the ediacaran sediments. Hence, possibility can not be ruled for their occurrence in deep time than Mesoproterozoic because of some species of the present genera are also known from the Palaeoproterozoic strata (Buick and Knoll, 1999).

DISCUSSION

In the present study, recovered 12 meso-megascopic phytofossils bar diagram (Fig. 3) of varied shaped are unicellular to multicellular algae both filaments and thalloides referable to prokaryotes- Cyanophyta and eukaryotes-Chlorontophyta, Chlorophyta, Rhodophyta and Phaeophyta and usually recorded in marine sediments- khaki-grey, fine-grained siltstone and flagstone sediments of Proterozoic worldwide (see the references in introductory text). The preserved 06 epibionts multicellular taxa belong to Phaeophyta, are dominant over the 6 taxa and compare with known five divisions as detailed in systematic text shows ill, tapic, thin presevations as and smaller than the known from the different stratum of 1700 Ma old in China (Yan and Liu, 1998). The association of single layered unicellular *Chuaria circularis* association with *Tawuia dalensis* (Zhu et al., 2000), *Tyrasotaenia* (Hofmann and Jinbiao, 1981) known from the 1800 Ma (oldest) sediments are morphologically identical having informal preservation. The genus *Aggregatosphaera* is very important because of its affinities are biogenic and abiogenic based on the presence of small sized centric-ecentric condensed structures which compared and justified with Chlorophyta and Cyanophyta (references in text). A similar modern taxon chlorophyll a & b bearing community (Lewin, 1976) considered a new prochlorophyta division nearer to Cyanophyta (Lee, 1980). The Mesokaryote - dinoflagellates of Dinophyta proved by chemical analysis for 1500 Ma old sediments (Meng et al., 2005). Hence, Aggregatosphaera form is filling the gap between the prokaryotes and eukaryotes and considered older than 1600 Ma in age. The Latest Palaeoproterozoic to Ediacaran period carbonaceous phanerophytic taxa are diversification, complexity and explosion both morphometric (increasing in thickening, size) and huge quantity with good preservation (Hofmann 1994; Yan and Liu, 1998) than present from the other parts of the world including Indian subcontinents owing to minor stasis with out any taphonomic changes from older to younger Proterozoic sediments. The Cyanobacterial fossils are also earlier marked and followed the same phenomenon as large amount, elongated and broader trichomes admixture of isolated solitary small and large sphaeroidal cells and their aggregation forming colonies representing complexity from the Statherian to onwards in comparison to deep time sediments records that justified here through the analyses of Gunflint chert sediments (2000 Ma) of Ontario in Canada (Awramik and Barghoorn, 1977) and reviewed the published prokaryotes eukaryotes algae and invertebrate data (Knoll, 2003; Fedonkin, 2003). Increasing in morphology of fossils corroborates the view given for evolutionary trends with time based on the stasis change in algae owing to gene pool rather than environment (Anabar and Knoll, 1992). Taphonomic changes have been observed in prokaryotes of Meso/Neoproterozoic less in early Proterozoic (Knoll and Sergeev, 1995) and in a window open near by the end of the Terminal Neoproterozoic (Cook and Shergold, 1986). The identical fossils bearing similar TAI are also earlier recognized from the deep time possible Latest Palaeoproterozoic shale sediments (Yan and Liu, 1998) while blooming of epibionts (Seong et al., 1999) and advanced benthic algae (Butterfield, 2000) are from the Mesoproterozoic deposits. While molecular timescale of eukaryotic signatures (simple-complex) have also been studied from the Proterozoic sediments (Brocks et al. 1999; Hedge et al., 2004). In present assemblage, taphonomic affect is negligible owing to low content of chlorophyll b than the Late Mesoproterozoic to Ediacaran strata is propionate to thickness and size of forms.

A very good index or zone marker forms for Orosirian age (1874±9 Ma) coiled filamentous- *Grypania* debatable affinities: *Acetbulaira* bearing long stalk of Chlorophyta and *Spirulina* of Cyanophyta from the Negaunee Iron Formation, Michigan (Han and Runnegar, 1992; Schneider et al., 2002), Statherian age (1721± 90 Ma to 1599± 8 Ma) of two formations of Lower Vindhyan in India (Beer, 1919; Maithy and Babu, 1988); Ectasinian-aseptate loosely coiled with sinuous *viz. Sangshania* broader than *Grypania* of 1400 Ma in age (Du et al., 1986), multiparous branches form viz. *Palaeovaucheria* taxa of Xanthophyta from the 1200 Ma old sediments (Butterfield et al., 1990) and uppermost Stenian taxa *Longfengshania* and *Beltina* (Du et al., 1986) as well as explosion and diversified carbonaceous macrobiota more than 80 genus without biomineralized recorded from the Doushantuo formation (580-543 Ma) by numerous workers are devoid of in present assemblage. The ringoidal bigger sized impression described as *Grypania* (Sarangi et al., 2004) is very difficult to consider as a potential for evolutionary trends, a-biogenic origin, might be formed by the water percolation onto bedding plane due to cracks during rainy season.

Palaeoproterozoic eukaryotic signatures both biological and chemofossils are often controversial owing to scar records, poor preservation, uncertain geochronological age control and over interpretations till end of 20th century. Two views are opined for the diversification of life: i. A natural system of organisms development was proposed to the domains of archea, bacteria and eucarya (Woese et al., 1990) and conceptual aspect of the evolution of development in lineages that exhibit increasing phenotypic complexity (Arthur, 2002; Reif, 2007) owing to gene pool is closely related to ocean water chemistry for short life cycle biotic community including algae (Anabar and Knoll, 2002), ii. abiotic-environment plays a key role for such type processes (Tucker, 1992; Javaux et al., 2003; Schneider et al., 2002; Janhunen et al., 2007). The biotic factor (gene pool) and abiotic factors with their each character are equally important to rectify the unusual thoughts created by the isolated studies through different methods.

The affinities of Proterozoic carbonaceous forms both algae and some lower invertebrate respectively are dealt by renowned earth scientists. The present assemblage is justified here as algae under the umbrella of "the present is the key and history of past" because the habit, habitat and life duration of algae and sponges including annelids are different. The animals having symmetrical body are usually to be seasonal appearance, found in organic rich nutrients available near seashore and move away from adverse environment condition for the saving and continuation of their generation for a long period while algae, after facing numerous catastrophs since the Archaean period is surving and less affected owing to short life cycle period, neritic and diversified in Neoproterozoic. There are very rare chances for the soft bodied lower invertebrate's preservation after death in form of carbonaceous (Walter et al., 1990) which body decomposed by bacterial activities and also disintegrated by acid maceration. The natural episodic changes affect on Eh, Ph concentration, nutrients only and least alteration on cyanobacterial gene pool. The tissue grading-multicellularity has been recorded in macerated residue by low concentration of HF, HCl and added with earlier known similar biocommunities from ca. 1700 Ma sediments (Yan and Liu, 1998). The natural occurring organic compound are biodegradable (Alexandre, 1973) through natural cycle of decomposition be prematurely and wholly terminated in higher biocommunities is proved here in lower invertebrates rather than algae. The affinities of Proterozoic carbonaceous mega bio-remains discussed very well (Towe et al., 1922; Hofmann, 1994). The carbonaceous preservation of the present forms is light grey colour owing to presence low content of chlorophyll b having Fe^{3+} in Palaeoproterozoic, dark grey colour in Mesoproterozoic (Hofmann, 1985); pyritized *Chuaria* in Neoproterozoic sequence of China (Yuan et al., 2001), clearly indicates evolutionary trend of iron element in lower plants and totally absent in invertebrate.

Proterozoic *Chuaria-Tawuia-Tyrasotaenia* assemblage occurrences are worldwide and wide geographic dispersal viz. Africa, China, India, Spitsbergen and North America. The morpho-anatomical features of *Chuaria* have two to three dimensional preservation, simple to multi-lamellate, thin to thick margin, light-dark grey-pyritzed and .02-10 mm in size in Proterozoic (Samulesson et al., 1999, 2001; Yuan et al., 2001; Javaux et al., 2003; Dutta, 2006; Singh et al., 2009). Palaeoproterozoic compression of *Chuaria* associated with *Tawuia* like records from the Statherian sedimentary platform deposits of China (Zhou et al., 2000) that skipped during review for the fixing of the affinities (Dutta et al., 2006). The *Chuaria* taxa considered as acritarch (Hofmann, 1977) and three acritarch taxa isolated from the *Chuaria`s* compressions (Maithy and Shukla, 1984) representing polyphytic taxa of prokaryotes (Yuan et al., 2001). The genus *Tawuia* is most dominating carbonaceous macroscopic remains and globally distributed during Mesoproterozoic- Neoproterozoic sedimentary deposits (reviewed Javaux et al., 2004; Dutta et al., 2006; Singh et al., 2009). The decreasing of frequency of Tawuids from 30 to 10% in comparison to Chuarids, *Chuaria* sizes less than 1 mm and decreasing holdfast sizes in other forms from the 1000 Ma to in deep time (Palaeoproterozoic). Recently *Chuaria* and its allied forms association with *Tawuia* is an indicative of a life cycle of an alga taxon (Maithy and Babu, 2005) and also represent morpho-physiological evolutionary trends. The critical analysis of both taxa association based on earlier records suggests the stratigraphic values (references in introductory part) rather than long ranging by few Indian palaeobiologists basing on superficial knowledge.

The integrated studies-morpho-anatomy and molecular biology from the Mesoproterozoic sequence of Roper group, Western Australia (Javaux et al., 2003) have been carried out by most advance technology for the earlier described varied shapes and sized fossils: *Chuaria, Tawuia*, *Shaushenia* and solitary, multicellular filaments – *Tyrasotaenia* from 1800- 1700 Ma sedimentary strata of China (Hofmann and Jinibiao, 1981; Zhu et al., 2000). The dates of these forms looking like clasts (Lamb et al., 2007) for the descried fossils (Zhou et al., 2000) are based on Pb-Pb method (Zhang, 2000) and suggested possibility of eukaryotic algal origin: steranes in Palaeoproterozoic sediments (Lamb et al., 2007) instead of Mesoproterozoic to terminal Neoproterozoic (Hofmann, 1985). The darker tubes cf. vendotaenids are simple rather than Neoproterozoic and diverse assemblage that resembled *Longfengshania* (Zhu and Chen, 1995; Yan and Liu, 1997).

The earlier other studies: geology and allied disciplines with few biological reports of the Singhora Group as mentioned here to deduce age and environs and evolutionary history (references in age and environment text in this article). The size of the present carbonaceous biological remains are smaller and low frequency distribution than the 1700 Ma (Yan and Liu, 1998) would be low atmospheric oxygen concentration in comparison to Meso/Neoproterozoic strata because of area and density of aquatic algae are more and solely responsible.

The elements viz. C,H,N,O,S and Mg in sea and ocean water, temperature, ecology and pH have also been considered by various workers as key tools to eukaryotes for their developments and occurrences. Within eukaryotes, the upper temperature of floralistic growth including algae is about 60 °C and much lowers than bacteria and archaebacteria (Noffke et al., 2006); pH 5-8.5 ranging for eukaryotic marine microplanktons and their sizes auto regulation-autolysis through gene pool (biotic factors) regulated by the ocean water chemistry owing to their short life cycle (Anabar and Knoll, 1992), towards natural system (Woese et al., 1990) than other plantae sized based on the adapic factors (Javaux et al., 2001); and also macroevolution and macroecology through deep time (Butterfield, 2007) based on his feelings and considering importance of the available report. The increased nitrate input in ocean give the clue for the evolution of photosynthetic eukaryote such as red and green algae (Knoll and Holland, 1995). Concentration of the Eh and Ph might be changed by heterogenous environments (Riding, 1992) and could not affected on algae gene pool owing to short span time of the life cycle (24-72 hour) because of gene pool controls the sizes of the cryptogams rather than the higher group of plantae.

The fossil biocommunities are most important to resolve the ecology and sedimentary history in shale due to lacking of sedimentary structures and can be distinguished by the presence of the fossils such as admixture of clean and muddy water. *Eopalmaria pristina* Yan (Plate 1h, k and l) and similar forms was described as new genus *Drydenia* belongs to Phaeophyta from the Devonian sediments of New York suggested intertidal condition (Fry and Banks, 1955). The proliferated extant phaeophytes are mostly seen in mudflat at the transitional zone wet and dry land (tropical environment) and extinct diversification of life at the transition PC/C (Tucker, 1992). The fragmentary thalloid compression of the fossil exhibits an unusual set of characters in their internal structures. The pseudo parenchyma like structures might be formed interwoven small tube structures that are also found as sheath of multicellular elongated broken of the parastem during processes of the samples. The red algae are usually grown in warm Sea and their proliferation recorded from the Cryogenian period. Preservation behavior of the thallus seems to have evolved in low energy near shore to brackish water; lagoon like environment within the photic zone supports a view of benthic habitat (Yan, 1995; Yan and Liu, 1997; Wang et al., 2008). The Palaeoproterozoic carbonaceous assemblage indicates same Eh and pH condition within the wide geography world over. Silty shale is an indicative of intertidal deposition (Zang, 1997). The algal thalli grew in quite; coastal areas with low rate fine grained sediment influx and their which high biological productivity and nutrients are some what are coeval. Various filamentous and coccoidal forms are also described from the intertidal sedimentaries deposits (Knoll et al., 1991).

The role of climate was also assigned for the frequency and morphological nature of biology (Riding, 1992; Schneider et al., 2002; Janhunen et al., 2007). The oxidative signatures without fossil morphology recorded from the episodic change- ice age in oldest Palaeoproterozoic (Bekker and Kaufmann, 1999). Microbenthic fossils with variant taxa, are considered indicator of tidal flats (Kah and Knoll, 1996), possibly the progenitor of such present types of benthic meso-megascopic carbonaceous eukaryotes because sudden morphogenic changes and khaki-grey silty shales bed is the indicative of seasonal intertidal, stable, shelf environment for the Saraipali Formation sedimentaries. The development is monophyly in higher plants, not relevant hypothesis to Precambrian plants that had at least 8 lines (polyphyly) in place of monophyly (Reif, 2007) because of the thermal evolution which response to life essential isotopic secular changes and behaviours like motion and alterations in plates on earth.

The energy producing elements (Uranium and Sulphur) and biorelics viz. *Conophyton* consisting not well marked laminae considered as marker forma for the Palaeoproterozoic /Mesoproterozoic from the basal most formation (Sinha et al., 1998, 2001; Gupta, 2004) of Chhattisgarh Supergroup and its equivalent in other different Precambrian sedimentary basins in peninsular India corroborated with known akin data from the equivalents of the world. This is an indicative of thrust zonal activity in geological past. Saripali Formation underlies the Rehatikhol Formation which consisted of not more than 5 ppm Uranium radioelement and Sulphur isotopes would be suggested hydrothermal signatures based on the presence of tuffaceous porcellanites, sediments analyses and their history for geothermal (Sinha et al., 1998) and responsible for hyper-thermopile subjected to episodic changes in the basin. The volcanic activity by natural catastrophe observed at the basal most part of the Singhora Group (2100-1900 Ma) which would be an utmost responsible for growth of the flora at the overlying Saraipali Formation. There is no glaciated signature in Chhattisgarh basin as observed first glacial event based on akin forms in Palaeoproterozoic from other parts of world (Kopp et al., 2005; Kirschvink and Kopp, 2008). Hence, the depositional environment of the Saraipali Formation is interpreted as a neritic, stable shelf, intertidal platform and warm condition (Mesophile-45°C) based on present finding as opined Indian earth scientists based on other parameters for the Singhora Group.

The present assemblage altogether earlier reports on carbonaceous meso-megaremains from the Palaeoproterozoic-Neoproterozoic sediments show the advent of multicelluarity and unicellular eukaryotes on earth, a supporting testimony to chemo-signatures in deep time as given (Brocks et al., 1999; Summons and Walter, 1990; Hedge et al., 2004). The fossils from the Saraipali Shale, are smaller size, preserved as organic debris on the bedding plan indicative of low oxygen and consistency in morphology from micro to megascopic levels respectively and a transitional phase of evolution shows polybiont stage of megascopic algae during earliest Statherian period in world. The root/host of it's would be late Palaeoproterozoic Cyanophyta while mycobionts and phycobionts habit observed only in terminal Neoproterozoic sediments (Shukla et al., 2004).

Now a days, in absence of radiometric dating minerals, acritarchs and chemo fossils (steranes, hophanes, DNA and RNA), the morphology, size, preservation and frequency of macro carbonaceous megaremains are used as third excellent clues towards in solving uncertain age, understanding evolutionary trends/history, biostratigraphy and micro-palaeoenvironments in geological past keeping in view to error possibility either instrument standardization or collection of improper field data towards absence of sedimentary structures.

Conclusion

The comprehensive analysis of the present generated biological data based on characteristics in the preservation, morphology with thickness including available data onto both isotope and census of palaeobiology provide unfolding of various secrets of the past in Chhattisgarh Basin as mentioned below.

1. Added 12 megascopic carbonaceous mesophile(30-45°C) algae with the known Palaeoproterozoic assemblage across the world.
2. The occurrence of present small sized and low amount of macrofossils suggests earliest Statherian age of the Saraipali Formation.
3. Record of first and oldest diversified algae from the Indian subcontinent sedimentaries and second time in world.
4. Rhodophyta extents back to 1200 Ma.
5. Diversification of Phaeophyta from the earliest part of Statherian period represents more sensitive gene pool rather than other algae.
6. Possibility of prochlorophyta based on *Aggregatosphaera* genus characters bridging between Cyanophyta and Chlorophyta.
7. The Cyanobacteria would be ancester and root of the Chlorophyta, Rhodophyta and Phaeophyta Xanthophyta rather than other algae.
8. The present finding demonstrates polybiont algal diversion= paraphylly during 1800 -1700 Ma.
9. Stabilization of rising sea temperature from Rehatikhol to Saraipali Formation would be 200 Ma span time (between Palaeoproterozoic and Mesoproterozoic).
10. The atmospheric oxygen concentration would be ranged (between 3-5 PAL) more than the Orosirain (2.1 Ga).
11. The finding indicates two type environment setting: i. stable platform; periodic oscillation – tidal flat for lower part and ii. Neritic zone (shallow=lower shelf), warm intertidal and conditions.

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