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HELICALLY COILED CYANOBACTERIAL MICROFOSSIL *OBRUCHEVELLA* FROM THE SARADIH LIMESTONE, RAIPUR GROUP, CHHATTISGARH SUPERGROUP, INDIA

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ABSTRACT

In the present study well-preserved specimens of *Obruchevella* Reitlinger- a helically coiled cyanoprokaryote microfossil are recorded for the first time from the carbonaceous shale of the Mesoproterozoic Saradih Limestone of the Raipur Group, Chhattisgarh Supergroup. Three species of *Obruchevella* viz., *O. delicata*, *O. exilis* and *O. parva* are recorded as organic-walled microfossils. In the global context, recovered species of *Obruchevella* are widely distributed in Mid-Neoproterozoic (Cryogenian) to Devonian silicified and organic-walled microfossils assemblages. Therefore, the occurrence of *Obruchevella* in the Raipur Group sediments has biostratigraphic implications for the claim of the recently assigned Mesoproterozoic age for the Chhattisgarh Supergroup.

Keywords: *Obruchevella*, Saradih Limestone, Chhattisgarh Supergroup, Neoproterozoic, Microfossils.

INTRODUCTION

The Proterozoic successions are considered as a repository of carbonaceous microfossils across the world. Several Proterozoic deposits known to contain mixed assemblage of prokaryotic and eukaryotic microorganisms (Knoll and Sergeev, 1995; Sergeev, 2009; Sergeev *et al.*, 2012; Tang *et al.*, 2013, 2015; Singh and Sharma, 2014; Javaux and Knoll, 2017). Besides, the helically coiled cyanoprokaryotic microfossil *Obruchevella* Reitlinger of Oscillatoriacean family has drawn maximum attention of palaeobiologist on account of its typical morphology. It is a commonly recorded filamentous form that ranges in age from the Latest Palaeoproterozoic (?) to Devonian. However, they are widely reported from the siliciclastic sediments close to the Precambrian- Cambrian boundary successions of Australia, Alaska, Canada, China, Greenland, India, Mongolia, Russia, and Saudi Arabia (Mankiewicz, 1992; Burzin, 1995; Prasad *et al.*, 2005; Sergeev *et al.*, 2010; Sergeev *et al.*, 2012; Sharma and Shukla, 2012). In the geological account, helically coiled forms were initially reported by Reitlinger (1948) from the Early Cambrian sediments (Kutorgina Formation) of Aldan massif from Siberian Platform. So far, about 21 species of *Obruchevella* are globally known taxonomically through shape, size, and coiling pattern (Mankiewicz, 1992; Sergeev *et al.*, 2012).

In Indian records, *Obruchevella* has been reported from the Krol-Tal successions of extra peninsular region (Kumar and Rai, 1992; Tiwari and Knoll, 1994; Srivastava and Kumar, 2003; Shukla *et al.*, 2006; Tewari, 2007; Shukla *et al.*, 2008; Tiwari and Pant, 2009) and from the Vindhyan Supergroup (Rai and Singh, 2004; Prasad *et al.*, 2005; Prasad, 2007; Singh *et al.*, 2011); Owk Shale of the Kurnool Group (Sharma and Shukla, 2012, 2016) of Peninsular region. In the present communication, for the first time we report the well-preserved assemblage of *Obruchevella* from the Saradih Limestone of the Raipur Group, Chhattisgarh Supergroup and discuss its biostratigraphical potential. During the last decades, studies on the Chhattisgarh Supergroup opened a new vista of our understanding of the lithostratigraphy, chronostratigraphy, evolution and age of this Proterozoic basin (Chakraborty *et al.*, 2015). Geochronologically the entire Chhattisgarh Supergroup is considered as the Palaeo-Mesoproterozoic sedimentary succession (Patranabis-Deb *et al.*, 2007; Bickford *et al.*, 2009, 2011a; Das *et al.*, 2009; Patranabis-Deb *et al.*, 2009; Basu *et al.*, 2010; Pandey *et al.*, 2012). However, the palaeobiological age of the entire basin is poorly constrained. Except a few reports of stromatolites from the basin (Schnitzer, 1969; Moitra, 2003; Gupta, 2004), fossil contents are poorly documented from the Chhattisgarh Supergroup (Babu and Singh, 2011; Singh and Babu, 2013; Babu *et al.*, 2014; Singh and Sharma, 2016). In this context the presence of age (Vendian) restricted taxa *Obruchevella* in the Raipur Group would play an important role to ascertain the age of the upper Chhattisgarh succession.

GENERAL GEOLOGY AND AGE

Sedimentary succession of the Chhattisgarh basin is exposed over 33000 km^2. About ~2300 meters thick Proterozoic Chhattisgarh Supergroup is unconformably overlies the Bastar Craton. It is divided into two sub-basins: (i) the Hirri Sub-basin to the west, (ii) the Baradwar Sub-basin to the east (Table 1). Lithostratigraphically it is divided into three groups *viz.*, the Singhora, the Chandarpur and the Raipur in ascending order (Das *et al.*, 1992) (Fig. 1). In the Hirri sub-basin, only two groups *viz.*, the Chandarpur and Raipur Groups are exposed whereas, in the Baradwar sub-basin all the three groups are exposed. Based on further revision of lithostratigraphy a new 'Kharsia Group' was designated above the Raipur Group (Patranabis-Deb and Chaudhuri, 2008) (Fig. 2) (Table-2). Subsequently, within the Chhattisgarh Supergroup the status of the Singhora Group, as an independent identity, was questioned and was considered as

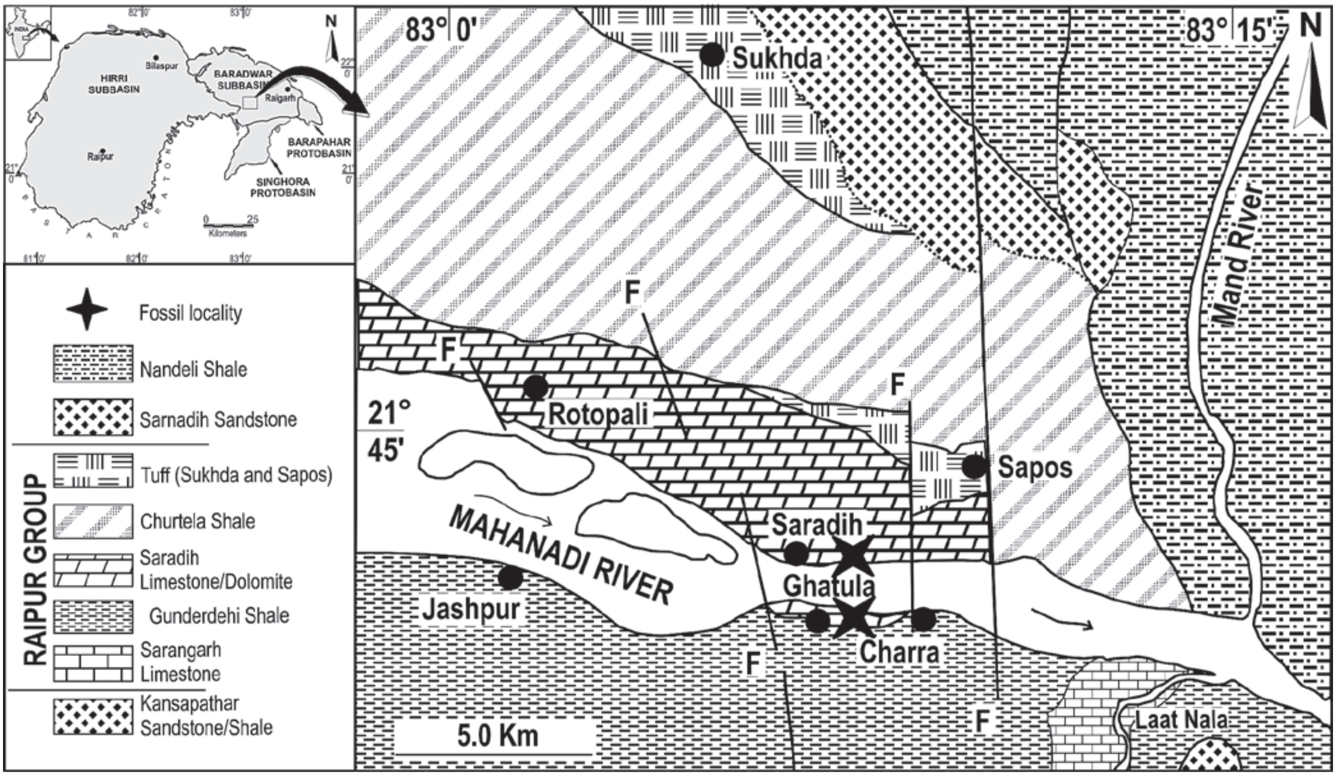


Fig. 1. Generalized geological map of the Baradwar Sub-basin in and around Saradih area showing the location of the study area (modified after Patranibs-Deb and Chaudhuri, 2008).

an extension of the Chandarpur Group (Dhang and Patranabis-Deb, 2011). A debate on the lithostratigraphic succession of the Chhattisgarh basin is well discussed (Basu *et al.*, 2013). Recently, a new lithostratigraphic column has been proposed on the basis of a detailed sub-surface data obtained from 350 drill holes, wherein the inception and development of the entire Chhattisgarh basin is proposed (Mukherjee *et al.*, 2014; Chakraborty *et al.*, 2015). In this scheme of lithostratigraphy, all the four designated groups have been retained with minor modifications at the level of formation (Table 1).

The Baradwar Sub-basin occupies an area ~8000 km^2 located in the east of main Chhattisgarh Basin, ~2300 m thick succession of mixed siliciclastic-carbonate rocks association unconformably overlies the basement constituted by the Sonakhan Greenstone belt and Sambalpur granite (Patranabis-Deb, 2004; Chakraborty *et al.*, 2015). Predominantly carbonate dominated sediments (~950 m thick) of the Raipur Group, the third stratigraphic unit of the Chhattisgarh Supergroup, is well exposed in and around the Saradih area, about 22.4 km NNE of Sarangarh city in the Chhattisgarh State. A broad marine subtidal to intertidal palaeogeography has been invoked for the dominant stromatolitic succession of the Raipur Group (Moitra, 2003). However, Patranabis-Deb (2004) suggested shallow water platform for carbonate units of the Raipur Group exposed in Baradwar Sub-basin. It has been subdivided into four formations namely the Sarangarh Limestone, the Gunderdehi Shale, the Saradih Limestone and the Churtela Shale in ascending order (Patranabis-Deb and Chaudhuri, 2008) (Table 1). The Sarangarh Limestone - a lowermost unit of the Raipur Group, is gradationally overlies the Chandarpur Group of rocks, which is represented typically by black, brown, gray, and mauve limestone in an ascending order that grades into purple shale. The predominantly brown calcareous shale characterizes the overlying Gunderdehi Shale with minor green shale, stromatolitic limestone, sandstone, and tuff. The shale is the dominant constituent of this formation and occupies almost 90% of its thickness. The Saradih Limestone follows the Gunderdehi Shale, consisting mainly of limestone and dolomite with minor shale. In the Hirri Sub-basin, this unit is equivalent to Chandi Formation. The sedimentary architecture of the Saradih Limestone is characterized by thick interbedded dolomite with green shale and chert followed by limestone, black shale intercalation and massive dolomite (Patranabis-Deb and Chaudhuri, 2008). Dolomite with gentle dipping is the dominant lithology of this formation. The Churtela Shale occupies a stratigraphic position similar to that of the Tarenga Formation of Hirri Sub-basin, which overlies the Saradih Limestone (Mukherjee *et al.*, 2014; Chakraborty *et al.*, 2015). This unit is characterized by a heterogeneous succession of red shale, green tuffaceous shale/mudstone with minor dolomite at places (Patranabis-Deb and Chaudhuri, 2008). Results of few palaeontological studies from the Raipur Group of rocks are available (Singh and Babu, 2013; Babu *et al.*, 2014).

Available geochronological data on the Chhattisgarh Supergroup are inconsistent. Distinct equivalent tuff bands are found in the Saraipali Formation, a part of the Shingora Group, and in the Khariar basin that is exposed south of the Chhattisgarh basin (Das *et al.*, 2009). EPMA dating of monazite and SHRIMP dating of zircon of the Khariar and Shingora tuffs show a concentration of ages around ~1500 Ma (Das *et al.*, 2009; Bickford *et al.*, 2011b). The basic dyke, intruding the overlying Chandarpur sediments at Damdama area, Raigarh

Table 1. Generalized stratigraphic succession of the Chhattisgarh Supergroup in Baradwar and Hirri Sub-basins (after Mukherjee *et al*., 2014).

	BARADWAR SUB-BASIN		HIRRI SUB-BASIN	
CHHATTISGARH SUPERGROUP	**Kharsia Group**	Nandeli Shale Sarnadih Sandstone	**Raipur Group**	Maniari Formation Hirri Formation
	~~Unconformity~~~			
	Raipur Group	Churtela Shale Saradih Limestone * Gunderdehi Shale Sarangarh Limestone		Tarenga Formation Chandi Formation Gunderdehi Formation Charmuria Formation
	Chandarpur Group	Kansapathar Formation Chaporadih Formation Lohardih Formation	**Chandarpur Group**	Kansapathar Formation Chaporadih Formation Lohardih Formation
	~~Unconformity~~~			
	Singhora Group	Chhuipali Formation Bhalukona Formation Saraipali Formation Rehatikhol Formation	Not Exposed	
Archaean Basement (Sonakhan & Sambalpur Granites)				

district has yielded 1641 ± 120 Ma Rb – Sr isochron date (Pandey *et al.*, 2012). The SHRIMP, U–Pb analysis of zircon from rhyolitic tuffs (Sukhda and Dhamda tuffs) found at the top of the Raipur Group yielded an age of ca. 1000 Ma (Patranabis-Deb *et al.*, 2007; Bickford *et al.*, 2011a). Bickford *et al.* (2011b) also obtained a concordia upper intercept age of 993 ± 8 Ma from magmatic zircon grains from the Dhamda tuff within the Tarenga Formation (coeval with the Sukhda tuff in Churtela Shale) in the uppermost part of the Chhattisgarh succession. It is now generally agreed upon by most of the researchers that the Chhattisgarh sediments were deposited between 1500 and 1000 Ma i.e., in the Mesoproterozoic time frame. These rhyolitic tuffs are considered as a major thermal event indicating the closer of sedimentation in the Chhattisgarh Basin (Patranabis-Deb and Chaudhuri, 2008) similar to the Vindhyan Basin (Malone *et al.*, 2008). Later, tuffs have been recorded at various other levels in the underlying formations making the stratigraphic positions of dated tuffs questionable (Mukherjee and Ray, 2010). Thus, the geochronological data suggest that the Chhattisgarh Supergroup is Palaeoproterozoic- Mesoproterozoic in age. A dichotomy appears when these geochronological dates are assessed along with the palaeontological records obtained from different units of the Chhattisgarh Supergroup.

Palaeobiological evidence recorded from the Chhattisgarh succession is meager and restricted to merely reporting of stromatolites (Schnitzer, 1969; Moitra, 2003; Gupta, 2004). Moitra and Dhoundial (1990) through their study of stromatolites in Raipur Group suggested a 1030 Ma to 630 Ma age for the upper part and 1350 Ma -1030 Ma to the lower part of the Raipur Group. The study of stromatolites in the Chandi Formation of Raipur Group suggested middle to Upper Riphean age (Chatterjee *et al.*, 1990). Permineralized microfossils found in the Saradih Limestone (unit below the Sukhda Tuff) indicate Cryogenian age (Babu *et al.*, 2014). Latest Palaeoproterozoic (~1750 Ma) age was suggested, based on the carbonaceous remains of eukaryotic affinity from the Saraipali Formation of Singhora Group (Babu and Singh, 2011, 2013). Recently, organic- walled microfossil *Jacutianema solubila* was documented from the Chaporadih Formation suggesting latest Mesoproterozoic (Stenian) age for the Chandarpur Group (Singh and Sharma, 2016). Above mentioned palaeontological records suggested Mesoproterozoic-Neoproterozoic age for the entire succession contrary to the recent geochronological data that support Mesoproterozoic age for the Chhattisgarh Basin (Basu and Bickford, 2015).

MATERIAL AND METHODS

For palaeobiological studies, samples were collected from the carbonate unit of the Saradih Limestone, exposed on both the banks of Mahanadi River near Saradih Village (21°43'31.40"N; 83°07'36.16"E) in the Janjgir district, Chhattisgarh. The upper part of dolomite consists of black chert nodules (up to 15 cm). This chert is dense black, thinly bedded (0.5 – 1.0 cm), nodular (up to 40 cm long and up to 20 cm thick), ellipsoidal lenses (up to 15 cm long and up to 8 cm wide) show waxy luster on freshly broken conchoidal faces. Limestone is light to dark gray, fine-grained, commonly breaks with conchoidal fractures. Black shale occurs as a thin intercalated layer (~2-3 meter) within the limestone showing the prolific development of stromatolitic columns. Specimens observed in the present paper are recovered from the middle part of this section as depicted in the Fig. 2. Standard and modified palynological protocols (Grey, 1999) were applied in the chemical digestion of the rocks (maceration), using 40% hydrofluoric acid for the layer by layer recovery of microfossils and organic residue. Slow maceration techniques were applied to avoid the fragmentation and destruction of microfossils. Organic remains were mounted on the slides with the help of Canada Balsam (R.I. = 1.5). Light Microscopic (LM) studies were conducted on the fossils recovered from the carbonaceous shale. About 88 palynological slides were examined under Olympus BX51 transmitted light microscope at 40X and 100X (under oil immersion lens) magnifications for documenting the finer morphological details of recovered microorganisms. Recorded specimens were photographed and computed (size) on software supported Olympus DP 26 digital camera. Studied palynological slides, photomicrographs and associated samples are deposited in the repository of the Birbal Sahni Institute of Palaeosciences, Lucknow (BSIP). These can be retrieved vide statement no. BSIP-1517. England Finder co-ordinates are given for each specimen.

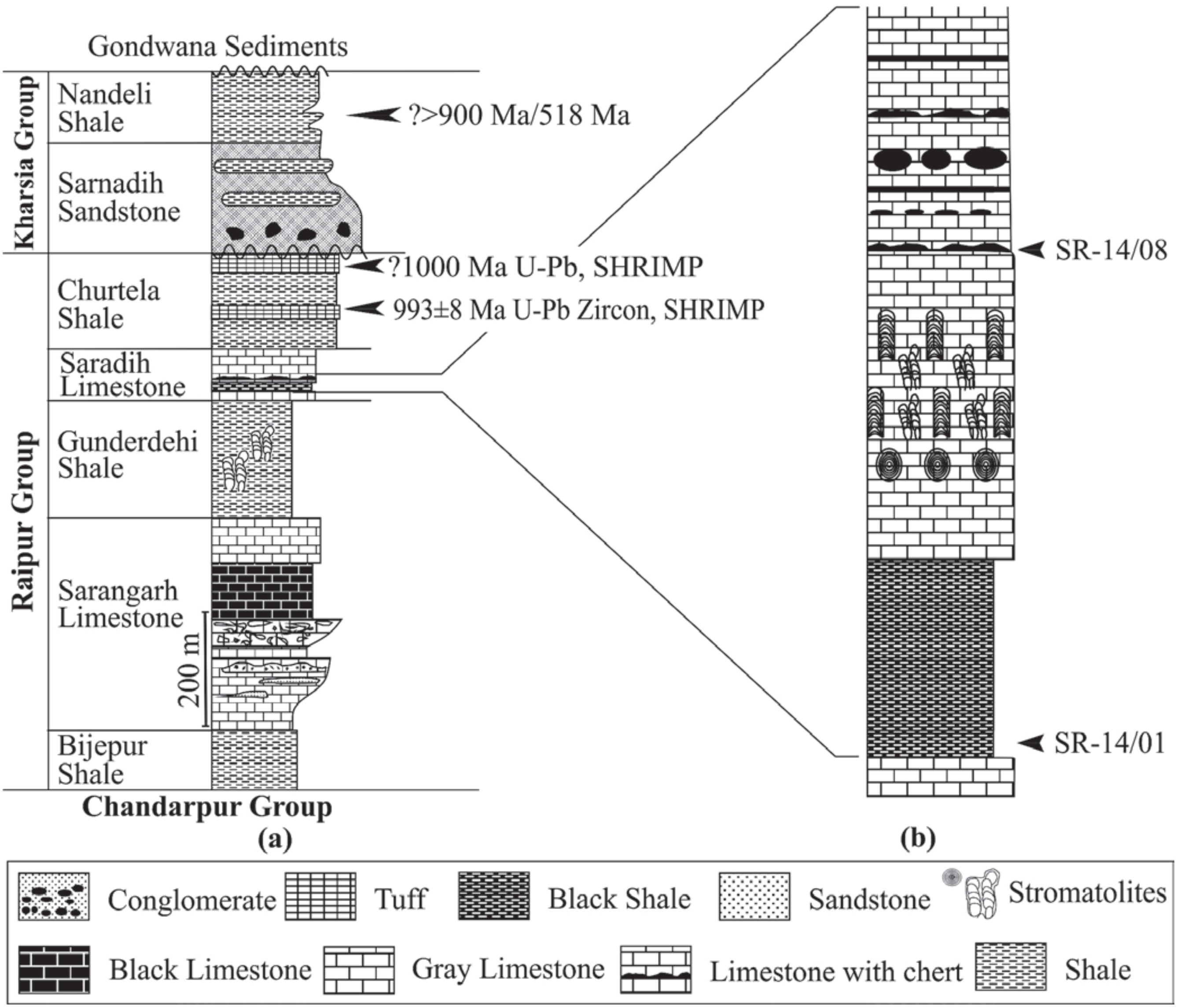


Fig. 2. Generalized lithostratigraphic column: **1.** Chhattisgarh Supergroup (after Patranibs-Deb and Chaudhuri, 2008) and **2.** Mahanadi River section at Saradih Village showing the sampling locations.

MICROPALAEONTOLOGY

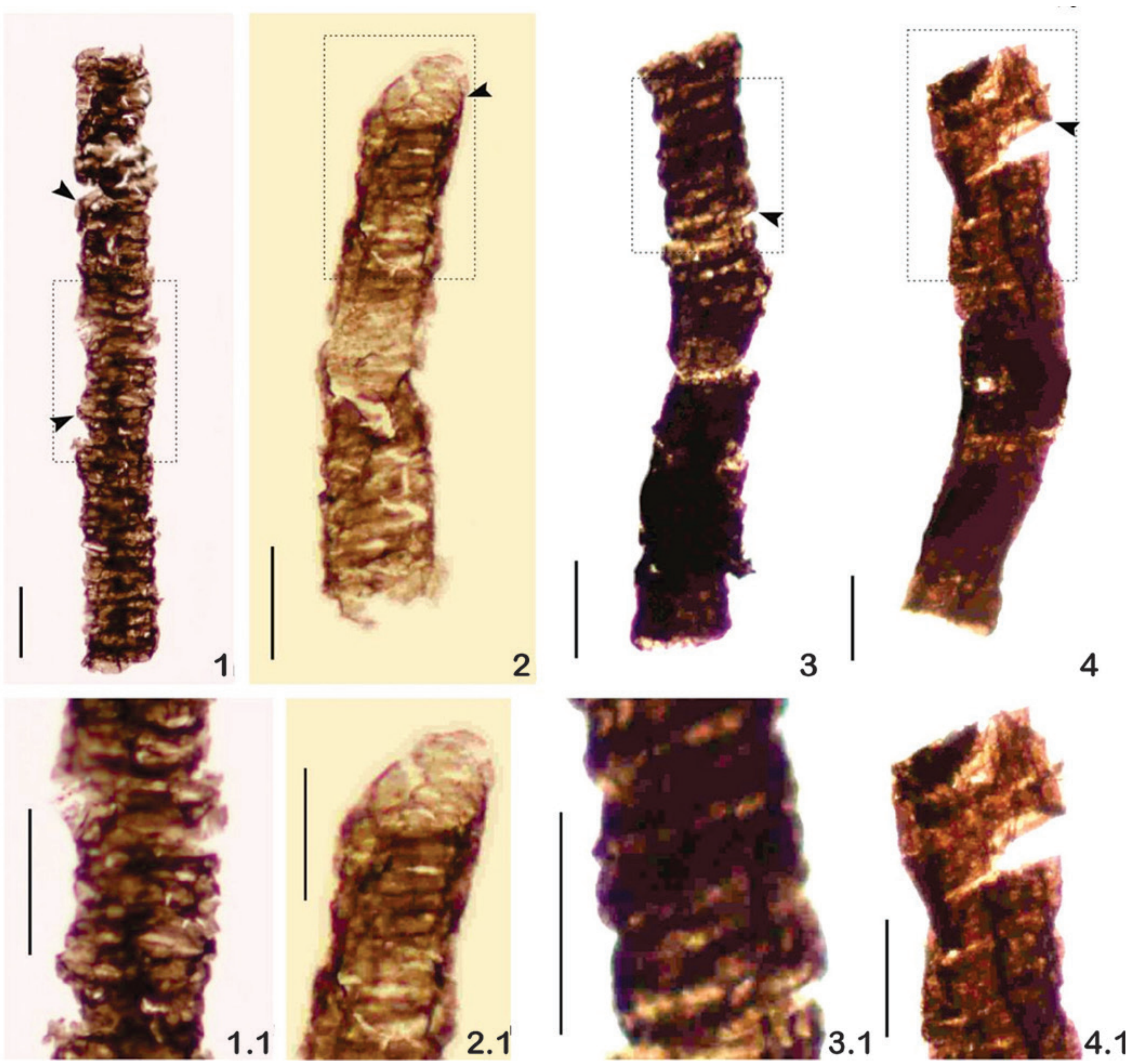
The carbonaceous shales from the Saradih Limestone have yielded the majority of exceptionally well-preserved Organic Walled Microfossils (OWMs). These are constituted of subsphaeroidal – spheroidal vesicles of the acritarch forms belonging to Sphaeromorphida subgroup followed by helically coiled filamentous cyanoprokaryote *Obruchevella* belonging to Oscillatoriacean family. In taxonomic composition, the microfossils are, three-dimensionally well-preserved, slightly compressed due to mutual compressions and display dark brown coloration. On the size parameters, tube diameter (1.56-9.87 µm), helix (7- 40 µm) and coil length (58-219 µm) vary in size, thick to thin walled and single layered. Following species of *Obruchevella* have been identified: *Obruchevella delicata, Obruchevella exilis* and *Obruchevella parva* (Plate 1, 2). The taxonomic details and geographic distribution of the identified specimens are provided below.

Kingdom **EUBACTERIA**
Phylum **CYANOPHYTA**
Class **HORMOGONEAE**
Order **OSCILLATORIALES**
Family **OSCILLATORIACEAE**
Genus ***Obruchevella*** (Reitlinger), Nagovitsin, 2000

Obruchevella delicata Reitlinger, 1948
(Pl. 1, fig. 4, 4.1)

Description: Tightly coiled, compressed empty tube, regular spiral that do not decreases in breath toward end. Helix diameter is 36.12 µm, whereas tube diameter is 9.87 µm, the total length of incomplete helically coiled specimen is 167 µm, tube walls are translucent and about 0.5 µm thick (n=1). Wall of spirally coiled tubes typically are closely adpressed but tubes can be more loosely packed due to *post-mortem* uncoiling.

Plate I



EXPLANATION OF PLATE I

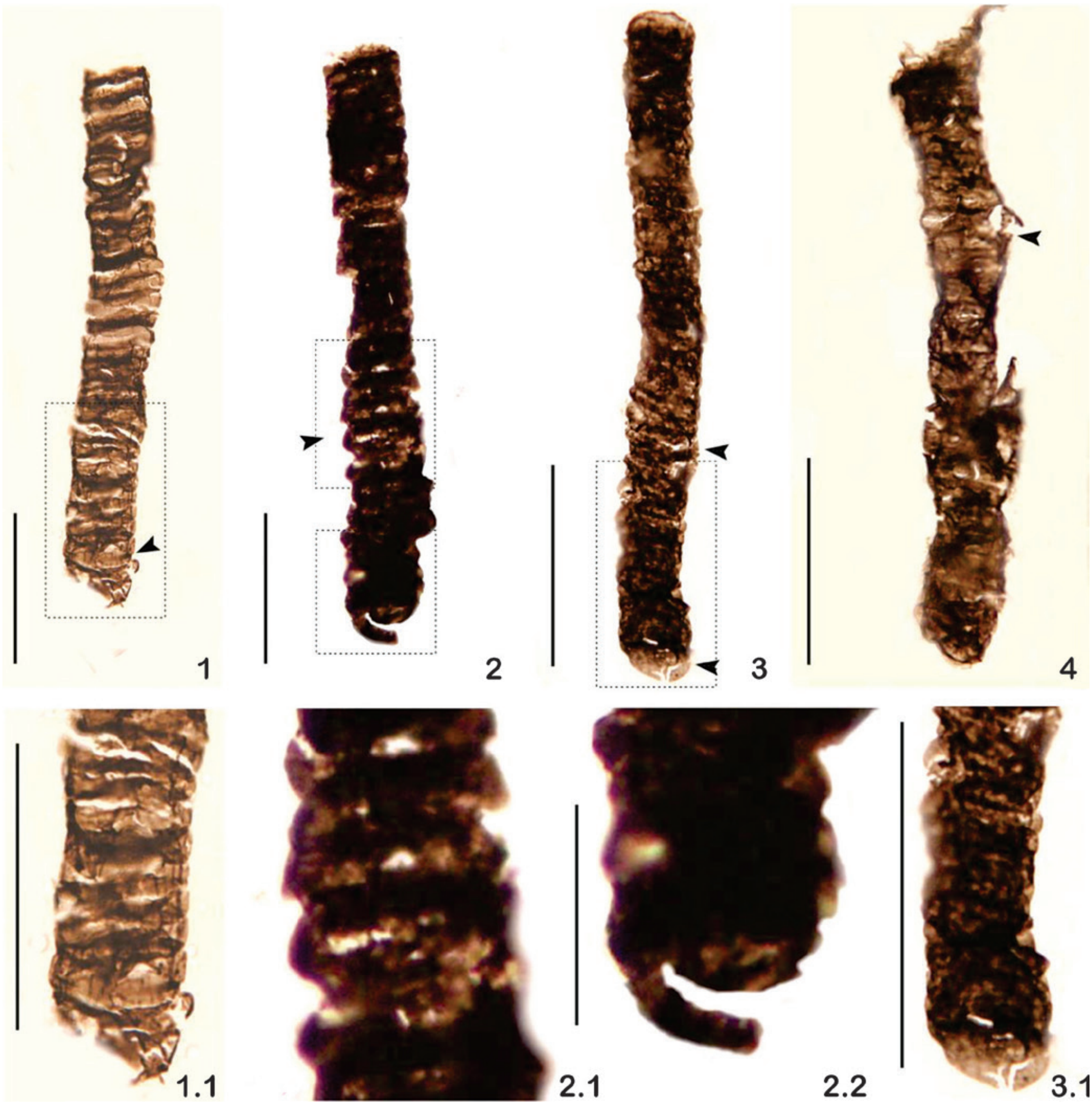
Helically coiled microfossil ***Obruchevella*** from the Saradih Limestone: Figs. 1 – 3. ***Obruchevella parva*** Reitlinger (a. Slide no. BSIP 16412, England Finder No. B27/2; b. Slide No. BSIP 16413, England Finder No. C36/2; c. Slide No. BSIP 16412, England Finder No. G36/3); Fig. 4. ***Obruchevella delicata*** Reitlinger (Slide No. BSIP 16412, England Finder No. G33/3). Box in 1-4 represent portion magnified and shown in 1.1'- 4.1': 1.1-3.1. magnified view of coiling pattern in ***Obruchevella parva***; 4.1. magnified view of coiling pattern in ***Obruchevella delicata***. Scale bar for each specimen = 25 µm. Arrows indicate prominent coiling in each specimen.

Remarks: The present specimen of *Obruchevella delicta* characterizes similar morphological characteristics with type specimen known from the Early Cambrian Kutorgina Formation of Aldan Massif, Siberia represented by a distinct intact helix, display helix diameter ranges from 36.4 to 71.5 and filament diameter range from 9.1 µm -18.2 µm (Reitlinger, 1948). Specimens of *O. delicata* in present report differs from the *Obruchevella parva* by the larger size filament diameter (9.87 µm) and helix diameter (36.12 µm).

Geographic distribution: *Obruchevella delicata* are widely reported from the Ediacaran (Vendian) successions. Siberia, Tinna Formation, Patom Uplift; India, Nagod Limestone, Bhander Group, Vindhyan Supergroup; Owk Shale, Kurnool Group; Lower Cambrian: Siberia, Sinna Formation, Patom Uplift; Kazakhstan, Chulaktau Formation; China, Yuhucun Formation and Canada, Burgess Shale.

Obruchevella exilis Sergeev, 1992
(Pl. 2, figs. 1-4, 1.1-3.1)

Plate II



EXPLANATION OF PLATE II

Helically coiled microfossil ***Obruchevella*** from the Saradih Limestone: Figs. 1-4. ***Obruchevella exilis*** (1. Slide No. BSIP 16414, England Finder No. L25/1; 2. Slide No. BSIP 16415, England Finder No. P50/4; 3. Slide No. BSIP 16414, England Finder No. J26; 4. Slide No. BSIP 16416, England Finder No. Q25). Box in 1-3 represent portion magnified and shown in 1.1-3.1: 1.1-3.1. magnified view of coiling pattern in ***O. exilis***. Scale bar for each specimen = 25 µm. Arrows indicate prominent coiling in each specimen.

Description: Non-septate, thin walled empty helically coiled filamentous microfossils, wound in to tightly coiled regular helix, with adjacent coils in close contact. Helix diameter ranges 7.0-13.0 µm whereas tube diameter 1.0-3.0 µm. Seldom complete specimens are found. The total length of incomplete spiral is 93.1µm. Tube walls are fine-grained, translucent and about 0.5 µm thick (n=5).

Remarks: The described specimens of *Obruchevella exilis* show similar morphological characteristics with the specimens known from Neoptoertozoic deposits of the Chichkan Formation, South Kazakhstan (Sergeev and Schopf, 2010). The illustrated specimens in the present assemblage differ from the

Table 2. Generalized lithostratigraphic succession of the Chhattisgarh Supergroup (after Das *et al*., 1992; Patranabis-Deb and Chaudhuri, 2008; Mukherjee and Ray, 2010). Age data source: 1. Bickford *et al*. (2011), 2. Pandey *et al*. (2012), 3. Das *et al*., (2009). *Fossiliferous unit.

	GROUP	FORMATION	LITHOLOGY	AGE
CHHATTISGARH SUPERGROUP	Kharsia	Nandeli Shale	Gypsiferous purple shale and dolomite	
		Sarnadih Sandstone	Sandstone and conglomerate	
	~Unconformity~			
	Raipur	Churtela Shale	Purple shale and Tuff	1000 Ma (Tuff)[1]
		Saradih Limestone	Dolomite/Stromatolitic Limestone, shale	
		Gunderdehi Shale	Calcareous shale with stromatolitic Limestone	
		Sarangarh Limestone	Flaggy Limestone and shale	
	Chandarpur	Kansapathar Formation	Quartz arenite	
		Chaporadih Formation	Glauconitic sandstone/siltstone, black shale	1641 ±120 Ma
		Lohardih Formation	Subarkose with basal conglomerate	(Dolerite Intrusive)[2]
	~Unconformity~			
	Singhora	Chhuipali Formation	Stromatolitic Limestone and Variegated shale	
		Bhalukona Formation	Quartz arenite and minor shale	
		Saraipali Formation	Variegated shale/siltstone, tuff/porcellanite	c.1500 Ma (Tuff)
		Rehatikhol Formation	Sandstone with conglomerate at the base	
	~Unconformity~			
	Archaean Basement (Sonakhan & Sambalpur Granites)			

other species of *Obruchevella viz., O. delicata* and *O. parva* in having smaller size filament diameter (1.0-3.0 µm) and helix size (7.0-13.0 µm). In some of the specimens tubes are more loosely packed due to *post-mortem* uncoiling (Pl. 2, figs. 1.1, 2.1). At the terminal tube is more loosely uncoiled (pl. 2 figs. 2.2, 3.1).

Geographic distribution: *Obruchevella exilis* is a common constitute of Neoproterozoic (Cryogenian to Ediacaean) successions. South Kazakhstan, Chichkan Formation; India, Owk Shale, Kurnool Group.

Obruchevella parva (Reitlinger 1949) Burzin, 1995
(Pl. 1 figs. 1-3; 1.1-3.1)

Description : Helically coiled long filamentous microfossil, coiled in regular cylindrical helix, do not taper towards end. The helix diameter ranges between 25-26 µm whereas tube diameter 2.0-4.7 µm. The total length of incomplete spiral is up to 220 µm (n=4). Tube walls are fine-grained, translucent and about 0.5 µm thick.

Remarks: In the present assemblage *Obruchevella parva* is distinguishable from the *Obruchevella delicata* in having slightly loose coiling and filament diameter (2.0-4.7 µm). In the Saradih specimens of *O. parva* slightly loose coiling may be the results of postmortem effect (Pl. 1 figs. a'-c').

Geographic distribution: *Obruchevella parva* is widely reported from the Ediacaran (Vendian) to Lower Cambrian organic-walled and silicified microfossils assemblages.

DISCUSSION

In recent years the, age constraint on the Chhattisgarh sediments, especially about the Raipur Group of rocks has improved considerably. Distinct rhyolitic tuff bands found in the Churtela Shale/ Tarenga Formation- a stratigraphic unit just overlying the microfossil bearing Saradih Limestone have been dated. The SHRIMP, U-Pb analysis of zircon from these tuff bands have yielded 1007±20 Ma (Patranabis-Deb *et al*., 2007) and 993±8 Ma (Bickford *et al*., 2011a).

In the taxonomic composition of the Saradh Limestone, three species of *Obruchevella* have been identified *viz*., *Obruchevella delicata* Reitlinger*, Obruchevella exilis* Sergeev and *Obruchevella parva* Reitlinger (Pl. 1 and Pl. 2). They are differentiated by their coiling pattern, tube thickness and helix diameter (Pl. 1. figs 1.1-4.1 and Pl. 2. figs 1.1-3.1). The other associated age potential microbiota reported from this unit (not part of the present communication) are *Glomovertella* Reitlinger*,* Vase Shaped Microfossil (VSM), *Milanocyrilium* Bloeser*, Trachyhystrichosphaera* Timofeev and Hermann*, Valkyria* Butterfield*, Heliconema* Hermann, and *Proterocladus* Butterfield. All these genera are known from different coeval units of Cryogenian to Ediacaran assemblages worldwide (Butterfield *et al.*, 1994; Sergeev and Schopf, 2010; Baludikay *et al.*, 2016). In particular, the Saradih assemblage is distinct from globally known typical Ediacaran Complex of Acanthomorphic Palynoflora (ECAP) in not having many characteristic forms of ECAP assemblage.

Stratigraphically, the most important form in the present finding is helically coiled cyanoprokaryote *Obruchevella* (Reitlinger, 1948). In biostratigraphy, this is a potential taxon which is considered as Ediacaran (Vendian) marker form, but recorded from the latest Tonian to Cambrian (Sergeev *et al.*, 2012) from the silicified cherts, shales and phosphorite rocks with a few exceptions (Zhang *et al.*, 1998). The earliest record of the *Obruchevella delicata* is from the Late Vendian sediments (550-541 Ma) of Zabit Formation, Siberia (Shenfil, 1983). This species have been documented from the coeval and younger sediments of the Siberian platform (Reitlinger, 1948; Yakshin and Luchinina, 1981); Canada (Voronova *et al.*, 1987); western Mangolia (Drozdova, 1980); eastern China (Xueliang, 1984); South Australia (Bengtson *et al.*, 1990), Peninsular India (Prasad *et al.*, 2005; Prasad, 2007; Sharma and Shukla, 2012). Similarly, the *Obruchevella parva* was initially recorded from the Early Ediacaran sediments (Golovenok and Belova, 1989; Knoll, 1992). This species became quite abundant in early and late Ediacaran assemblages (Mankiewicz, 1992; Prasad *et al.*, 2005; Shukla *et al.*, 2006, 2008; Sergeev *et al.*, 2012; Sharma and Shukla, 2012) and distinctly found in Early Cambrian assemblages (Mankiewicz, 1992). Likewise, *Obruchevella exilis* is originally recorded from the Cryogenian succession of the Chichkan Formation of South Kazakhstan (Sergeev, 1991;

Schopf *et al.*, 2010; Sergeev and Schopf, 2010; Sergeev *et al.*, 2010). Later, it has been documented from the Owk Shale of the Kurnool Group (Sharma and Shukla, 2012). Comprehensive analyses and global occurrence of these three species of *Obruchevella* and other Neoproterozoic age restricted microbiota especially Vase-shaped microfossils (VSM), as well as absence of typical ECAP fossils in Saradih assemblage, suggest latest Tonian – Cryogenian age for the Chhattisgarh Supergroup.

CONCLUDING REMARKS

1. Black shale of the Saradih Limestone is dominated by helically coiled cyanoprokaryote *Obruchevella* viz., *O. delicata; O. exilis* and *O. parva* in association with other Neoproterozoic (800-635 Ma) microbiota.
2. Worldwide *Obruchevella* is considered as Ediacaran marker microfossils having a specific position in biostratigraphy.
3. Global correlation with well-dated coeval assemblages shows that the Saradih Limestone is most likely Neoproterozoic (latest Tonian to Cryogenian) in age.
4. The occurrence of *Obruchevella* in the Saradih Limestone- a stratigraphic unit just below the tuff bearing Churtela Shale (= Tarenga Formation), opens a new challenge to the geochronologically proposed stratigraphic position of Sukhda and Sapos tuffs.

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