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RESTUDY OF AN EDIACARAN MEDUSOID *MARSONIA ARTIYANSIS* RAGHAV *ET AL.*, 2005, FROM THE JODHPUR SANDSTONE, JODHPUR DISTRICT, WESTERN RAJASTHAN

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ABSTRACT

A medusoid *Marsonia artiyansis* Raghav *et al.,* 2005 reported from the Jodhpur Sandstone of Ediacaran age has been restudied for its taxonomic affinity. The present study suggests modification in the diagnosis. The conclusion drawn by Raghav *et al.* (2005) concerning its affinity with a medusoid of Class Scyphozoa can be accepted on the basis of morphology characterized by a circular disc-shaped structure with smooth to wrinkled margin and mode of preservation in a very shallow water lagoonal setting. The animal must have been planktic with soft body without hard parts. The diameter varies from 0.5cm to 5.5cm with mean value as 1.08 cm, (n=60). In the centre, there is a circular mark. Much of the central part is uneven but marked by four arms and a few bead-like structures. The major variation in morphology is possibly due to taphonomy and load-effect of overlying sediments.

Keywords: Ediacaran, medusoid, *Marsonia,* Jodhpur Sandstone, Marwar Supergroup, Rajasthan

INTRODUCTION

Any new record of the Ediacaran fossils is always a welcome addition to our understanding of the early evolution of animal life. In India, there are many Neoproterozoic basins in which the Ediacaran fossils have been searched for more than a decade. Mathur and Shanker (1989, 1990) and Shankar *et al.* (2004) reported several forms of Ediacaran fossils from the Lesser Himalayan Krol Group of rocks. De (2003, 2006) reported Ediacaran fossils from the Bhander Group of the Vindhyan Supergroup while Kumar and Pandey (2008a) described *Beltanelliformis* from the Maihar Sandstone, the youngest formation of the Bhander Group in the Son Valley. Raghav *et al.* (2005) have erected a new genus and species of the Ediacaran medusoid and named it as *Marsonia artiyansis* from the Sonia Sandstone (Jodhpur Sandstone) of the Marwar Supergroup. Kumar and Pandey (2010) described two forms *Hiemalora* and *Aspidella* from the Jodhpur Sandstone. On the other hand, no attempt has been made to evaluate the biogenecity of the Ediacaran fossils reported from India. None of the Ediacaran fossils have been adequately documented and the quality of the published photographs is not up to the required standard. In none of the published photographs, it is possible to observe the diagnostic morphological features with certainty. The diagnosis of the form is mostly made by making line drawings of the poorly preserved structures with marked subjectivity. Such identifications of forms are of lesser value as most of the morphological features are inferred and imagined. Because of these reasons, the comparison of the Indian forms with the internationally approved genera and species does not have the desired level of confidence. In the light of this, the newly created medusoid form *Marsonia artiyansis* described by Raghav *et al.* (2005) from the Ediacaran Sonia Sandstone (Jodhpur Sandstone) of the Marwar Supergroup is restudied to establish its biogenecity as well as its taxonomic affinity. For this, a fresh collection was made in the abandoned mines near Artiya Kalan, about 66 km northeast from Jodhpur on Jodhpur-Gotan motor road from where Raghav *et al.* (2005) had collected their samples.

GEOLOGICAL SETTING

The Marwar Supergroup occupies a large area in western Rajasthan forming small hillocks in a desert setting (Fig. 1 A and B). The rocks are developed west of the Aravalli mountain chain and have been referred to as the Trans-Aravalli Vindhyans. The rocks are represented by the sandstone, siltstone, shale, conglomerate, dolomite and limestone, and are unmetamorphosed and undeformed. In general, the rocks are horizontal or show very low dips. The Marwar Supergroup has been subdivided into three groups viz., the Jodhpur Group, the Bilara Group and the Nagaur Group (Table 1). The Jodhpur and Nagaur Groups represent argillo-arenaceous facies, while the Bilara Group constitutes the calcareous facies. The Marwar Supergroup unconformably overlies the Malani Igneous Suite and the older metamorphic rocks. The Malani Igneous Suite has been dated as 771±5 Ma on the basis of U-Pb dating (Gregory *et al.*, 2009). The Marwar Supergroup is unconformably overlain by the Permian Bap Beds. Pareek (1981, 1984) has subdivided the Jodhpur Group into the Pokaran Boulder Bed, the Sonia Sandstone and the Girbhakar Sandstone but Chauhan *et al.* (2004) have merged both the Sonia Sandstone and the Girbhakar Sandstone with the Jodhpur Sandstone. Thus, the Jodhpur Group has been subdivided by Chauhan *et al.* (2004) into the Pokaran Boulder Bed and the Jodhpur Sandstone. The Pokaran Boulder Bed which attains a thickness of about 4m, is developed only in the southwestern part of the basin near Pokaran and in rest of the basin, the Jodhpur Sandstone lies unconformably over the Malani Igneous Suite. The Jodhpur Sandstone is represented by the sandstone, siltstone, minor shale and conglomerate and in the eastern part of the basin it directly overlies the Malani Igneous

Suite. It shows excellent development of parallel bedding with low-angled discordances, mega and small-scale cross bedding, wave and current bedding, wave and current ripples and interference ripples, microbial mat structures, salt pseudomorph structures, flaser bedding and mud cracks. The Jodhpur Sandstone seems to have been developed in high to moderate energy, beach-coastal sand, tidal flat-lagoon environment.

Sarkar *et al.* (2008) have reported a large number of microbial mat-induced sedimentary structures (MISS) from the middle part of the Jodhpur Sandstone (Sonia Sandstone). Kumar and Pandey (2009) have reported microbial mats *Arumberia banksi* and *Rameshia rampurensis.* They have also recorded *Hiemalora* and *Aspidella.* On this basis, the Jodhpur Sandstone has been assigned the Ediacaran age. The youngest group, the Nagaur Group has yielded assemblage of trace fossils dominated by *Rusophycus* and *Cruziana* and has, therefore, been assigned a Lower Cambrian age (Kumar and Pandey, 2008b, 2010). Raghav *et al.* (2005) suggested Vendian age to the *Marsonia artiyansis* bearing Sonia Sandstone (lower part of the Jodhpur Sandstone). Thus, the available geological data suggest that the age of the Marwar Supergroup can be bracketed between the Ediacaran and the Lower Cambrian, and the Jodhpur Sandstone containing *Marsonia, Hiemalora, Aspidella* and *Arumberia* can be assigned the Ediacaran age.

Table 1: Stratigraphic Succession of the Marwar Supergroup (modified after Pareek, 1984 and Chauhan *et al.*, 2004).

Age	Supergroup	Group	Formation	Lithology
Permo - Carboniferous			Bap Boulder Bed	
		Unconformity		
Early Cambrian	Marwar Supergroup	Nagaur Group (75-500 m)	Tunklian Sandstone	Brick red sandstone, siltstone & red clay stone
			Nagaur Sandstone	Brick red sandstone, siltstone & red and green clay beds
To		Bilara Group (100-300 m)	Pondlo Dolomite	Cherty dolomitic limestone
			Gotan Limestone	Interbedded dolomite & limestone
			Dhanapa Dolomite	Dolomitic limestone with chert lenses
Late Neoproterozoic		Jodhpur Group (125-240 m)	Jodhpur Sandstone	Reddish gritty sandstone with maroon clay beds
			Pokaran Boulder Bed	Conglomerate
		Unconformity		
Malani Igneous Complex / Aravalli Rocks				

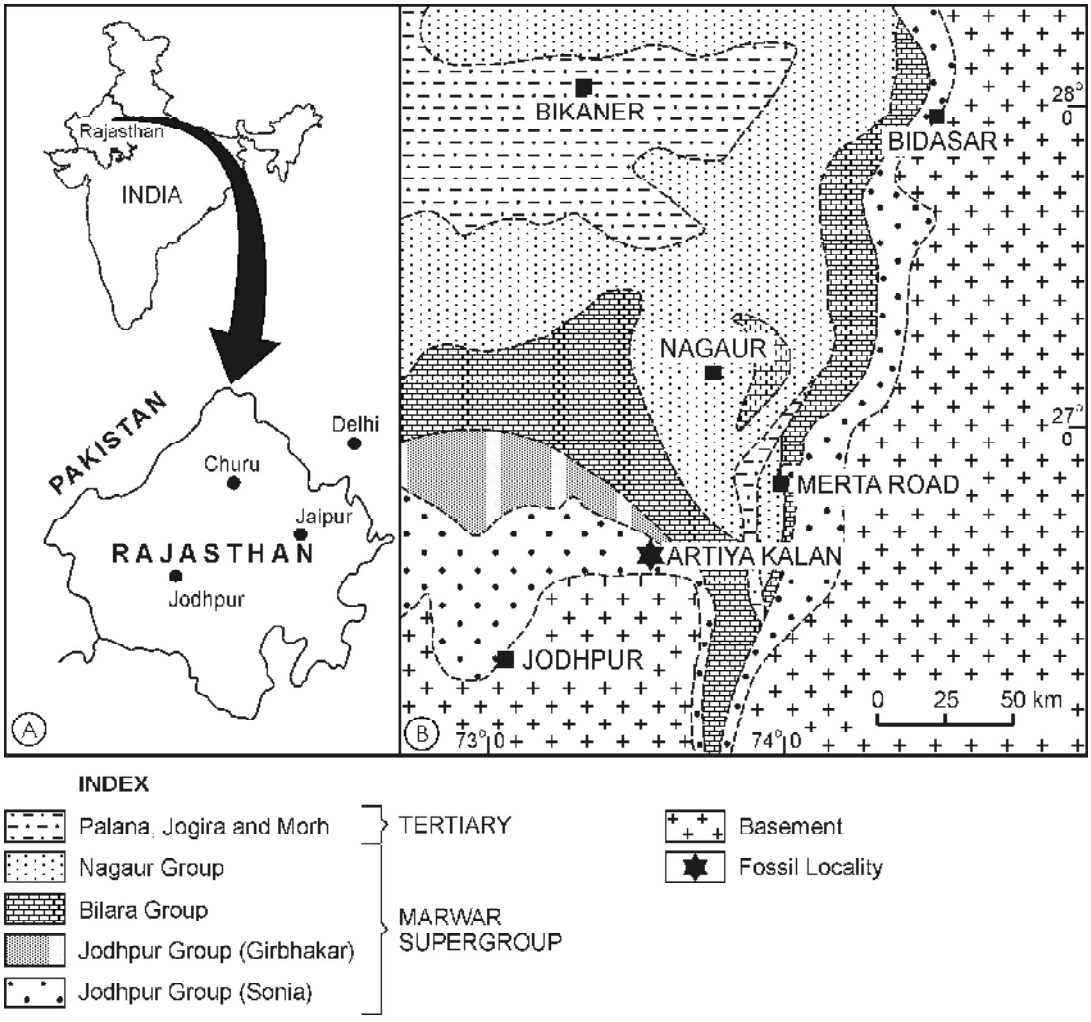

Fig. 1. A. Location map of the Jodhpur area, western Rajasthan. B. Geological map of the Jodhpur area, showing fossil locality. (Redrawn after Raghav *et al.*, 2005).

SAMPLING

The samples of *Marsonia* were found in the type locality near Artiya Kalan village of Jodhpur district, Rajasthan (Fig. 2). About 7m thick succession is exposed in the pits which are about 1km east of the village. The GPS value of the fossiliferous site is 73°24' 53''E and 26°33'10.5''N. Disc-shaped fossils were collected from the outcrops in the abandoned quarries. In the Artiya Kalan area, the Jodhpur Group is represented by the lower part of the Jodhpur Sandstone (Sonia Sandstone). The lower 2m thick unit is represented by thickly bedded light yellowish grey to brown coloured fine sandstone. It also shows ripple bedding while upper 5m is represented by red to reddish brown shales interbedded with thin brown and greenish siltstone and light grey sandstone. The siltstone also shows small-scale ripple bedding dominated by wave ripple bedding. Lenticular bedding and parallel bedding are the dominant bedding structures. Mud cracks and wrinkle marks are abundantly recorded. The fossils can be recovered by breaking highly friable shale along the fissility planes. No carbonaceous matter is recorded in the bed or within the fossils. Fossils are preserved as impressions on the flat bedding surface but some have slightly elevated relief. Some forms are embedded in the bed and their continuity can be traced within several mm thick units.

The environment of deposition of the fossil-bearing horizon seems to be a lagoon in a tidal-flat setting with very low-wave energy indicated by small-scale wave ripple bedding in the siltstones.

BIOGENECITY OF THE JODHPUR FOSSIL

The *Marsonia* has been first evaluated as biogenic structure before attempting its taxonomic assignment. It occurs as simple impression on the bedding surfaces of the shales. It is marked by a circular disc-shaped structure with well preserved wrinkle marks. Occasional presence of beads and arm-like structures within the disc-shaped structure is quite common. A few forms are preserved also as three dimensional body fossils, though quality of preservation is very poor due to friable and fragile nature of the host rock. Its morphology is such that it cannot be compared with any inorganically produced sedimentary structure such as the mud or sand volcano or waterscape structures. Its morphology is not comparable to any structure related to microbial mat-induced sedimentary structures as described in the 'Atlas of Microbial Mat Features' preserved within the Siliciclastic Rock Record' by Schieber *et al.* (2007). It cannot represent a resting trace of an animal as it is also preserved as three dimensional structures. Hence, it cannot be classed as a trace fossil.

It shows some resemblance with *Chuaria circularis* considered by Sharma *et al*. (2009) as having an algal affinity. *Chuaria* is characterized by circular shape, wrinkle marks and carbonaceous nature with diameter ranging from 2 mm to 1 cm (see Hofmann, 1992) but generally it is ca. 5 or 6 mm. The features which separate *Marsonia* from *Chuaria* are the noncarbonaceous nature, larger size and presence of arm and bead-like features in the middle part of the disc. Thus, if these structures are to be of organic origin, it should represent a soft bodied animal which must have been planktic and must have been living in a very low-energy shallow marine setting. Its morphology shows close affinity with a living medusoid.

TAXONOMY

In all, 60 samples of *Marsonia* were collected from the shales of the Jodhpur Sandstone (Sonia Sandstone). All the samples have been deposited in the museum of the Department of Geology, University of Lucknow, Lucknow.

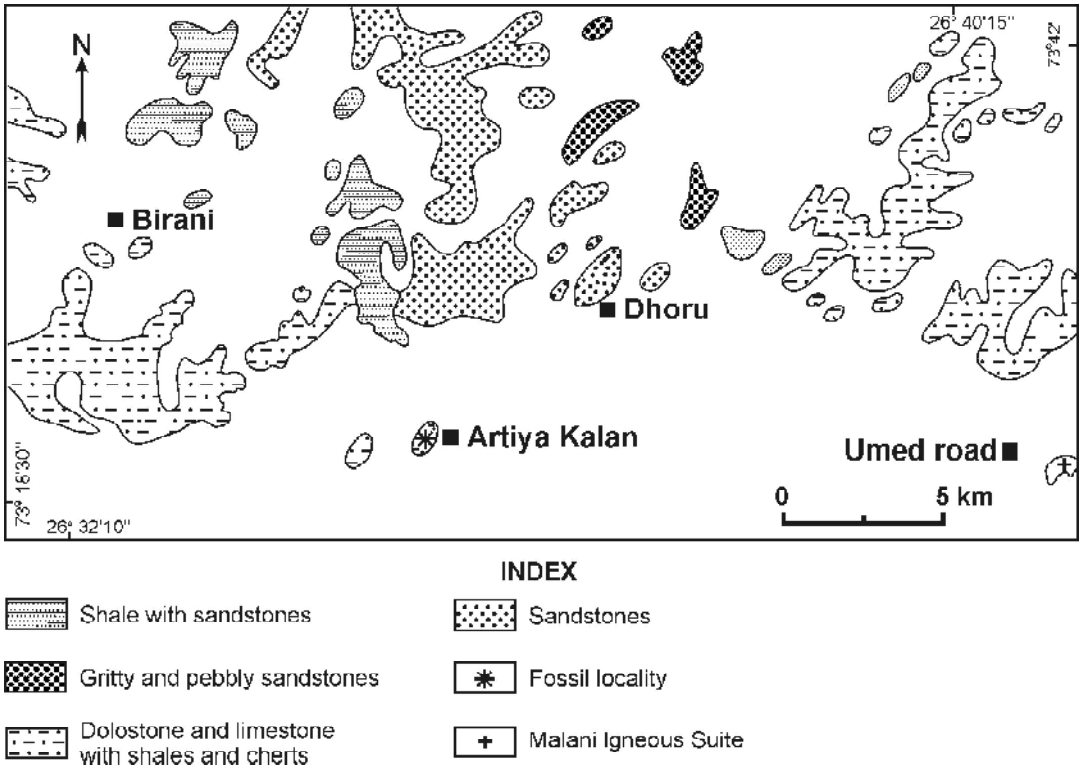

Fig. 2. Detailed geological map of the Artiya Kalan area, Jodhpur District, Rajasthan showing fossil locality. (Redrawn after Raghav *et al*., 2005).

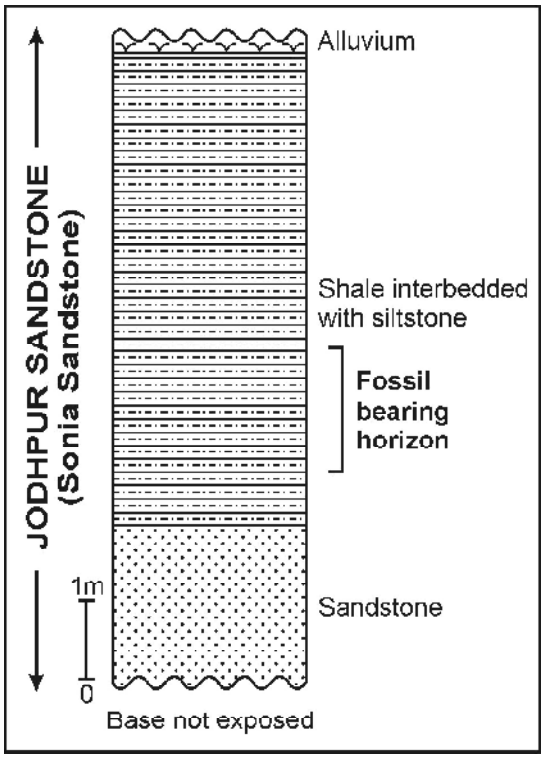

Fig. 3 Litho column of the fossil-bearing horizon, Jodhpur Sandstone, Artiya Kalan area, western Rajasthan.

Phylum **Cnidaria**

Class **Scyphozoa**

Family **Incertae sedis**

Genus ***Marsonia*** Raghav *et al.,* 2005

(Fig. 4C- E i-iii; Fig. 5 A-F)

Type species: *Marsonia artiyansis* Raghav *et al.* 2005

Holotype: Raghav *et al.* (2005) have identified 4 holotypes for the genus *Marsonia* which is not legitimate according to the rules of biological nomenclature. We have selected the best photograph shown in Fig. 3C of his published paper as Holotype whose sample number is not available.

Paratype: SK/AK-1, 16, 21, 23, 29, 30.32 a & b.

Diagnosis: It is disc shaped, generally circular to elliptical in outline marked by impression on the top of the bed (Fig. 4). The diameter ranges from 0.5 to 5.5cm. The outer peripheral margin of the disc is smooth (Fig. 4 D & Fig. 5 A, B, C, D) or marked by complex wrinkles (Fig. 4 C & Fig. 5 E, F). Wrinkled margins are slightly irregular and individual wrinkle could not be traced around the circular outer margin. The width of wrinkled part of the disc varies from 2mm to 4mm. Non-wrinkled part is marked by uneven surface and also shows small, straight to slightly curved ridges or arms, which are symmetrically or asymmetrically placed. They taper at the outer margin of the disc. The arms are originating from the centre but do not continue up to the outer margin. The maximum length of the arm has been measured as 2cm. In a few forms, the arms are placed in such a way as to divide the disc into four more or less symmetrical parts. In the central part of the disc a circular mark is preserved both as positive or negative epirelief with diameter ranging from 1 to 2mm (Fig. 5 C "a" and "b"). The central part of the disc also shows bead like structures (Fig.5 E); otherwise it is uneven. The outer margin of the bell is completely devoid of tentacles.

Remarks: A large variation is seen in the morphology of *Marsonia*. In some, the central part is uneven while in other few the arms are missing. In the larger forms, the wrinkle marks are prominent. The quality of preservation in the smaller forms is relatively better. It appears that the effect of compression or overloading was less in smaller forms in comparison to the larger forms. A few forms are embedded in the bed and have three dimensional preservation. It can be confirmed when small chips of shale is removed from the top surface of the fossils and some preservation could still be seen on the under surface suggesting continuity of the fossil body (Fig.4 E i- iii). Differences in the morphology of the fossil may also be due to the fact that whether the preservation is from the oral or aboral side of the medusoid.

Discussion: In morphology, the present form resembles the form described as *Marsonia* reported by Raghav *et al.* (2005). In their collection, they had only four samples and all were erroneously described as holotypes (see page 24, Raghav *et al.,* 2005). In the published photographs of Raghav *et al.* (2005) the morphology of the fossil can be observed only in fig. 3-A, B, C, F and G, out of which B, C, F and G are the photographs of the same sample. All the forms have a diameter of about 1cm. In none of the photographs, the wrinkles are seen but their presence has been mentioned in the description. Though the diameter is shown to be ranging from 0.4 to 1cm, no photograph is given for the smaller range. In fig. 3-A nothing is visible in the areas marked as 'b', 'c' and 'd'. In our collection, we could observe the morphology in the forms with more than 0.5cm diameter. Hence, the minimum diameter is taken as 0.5cm and the maximum diameter is recorded as 5.5cm, whereas Raghav *et al.* (2005) have given this range as from 0.4 to 1cm. The form is soft bodied without any hard part. The presence of arm-like structure, beads, opening in the centre, circular body, wrinkle marks in the outer margin and absence of hard parts point towards a medusoid of Scyphozoan affinity. Raghav *et al.* (2005) have placed *Marsonia* under phylum Cnidaria, class Scyphozoa and family Incertae sedis.

Marsonia artiyansis Raghav *et al.,* 2005, emended

(Fig.4- C to F; Fig.5-A to F)

Paratype: SK/AK-1, 16, 21, 23, 29, 30, 32 a & b

Description: As for the genus

Discussion: Specimens are characterized by circular to slightly elliptical shape and it is termed the bell which is an outer body in a jelly fish. The quality of preservation in smaller form is relatively better in comparison to the bigger forms. A notable character is that outer margin of the bell is smooth in the smaller forms and wrinkled in the bigger ones. Concentric rings are discontinuous and none of them makes a complete circle around the disc. This suggests that the outer part of the bell was very soft and thin. The smooth margin in the smaller forms and better preservation may be due to the fact that central part of the bell shaped animal was thicker as depicted in the schematic diagram in Fig. 6, where the transverse and oral sections of the animal are shown. It explains the preservation of complete body of the animal in the bigger form and in the smaller form only the nonstippled part is preserved. Outer margin of the bell is devoid of tentacles. The radial arms originating from the central disc may act as gastrovascular system in the animal (Raghav *et al.*, 2005).

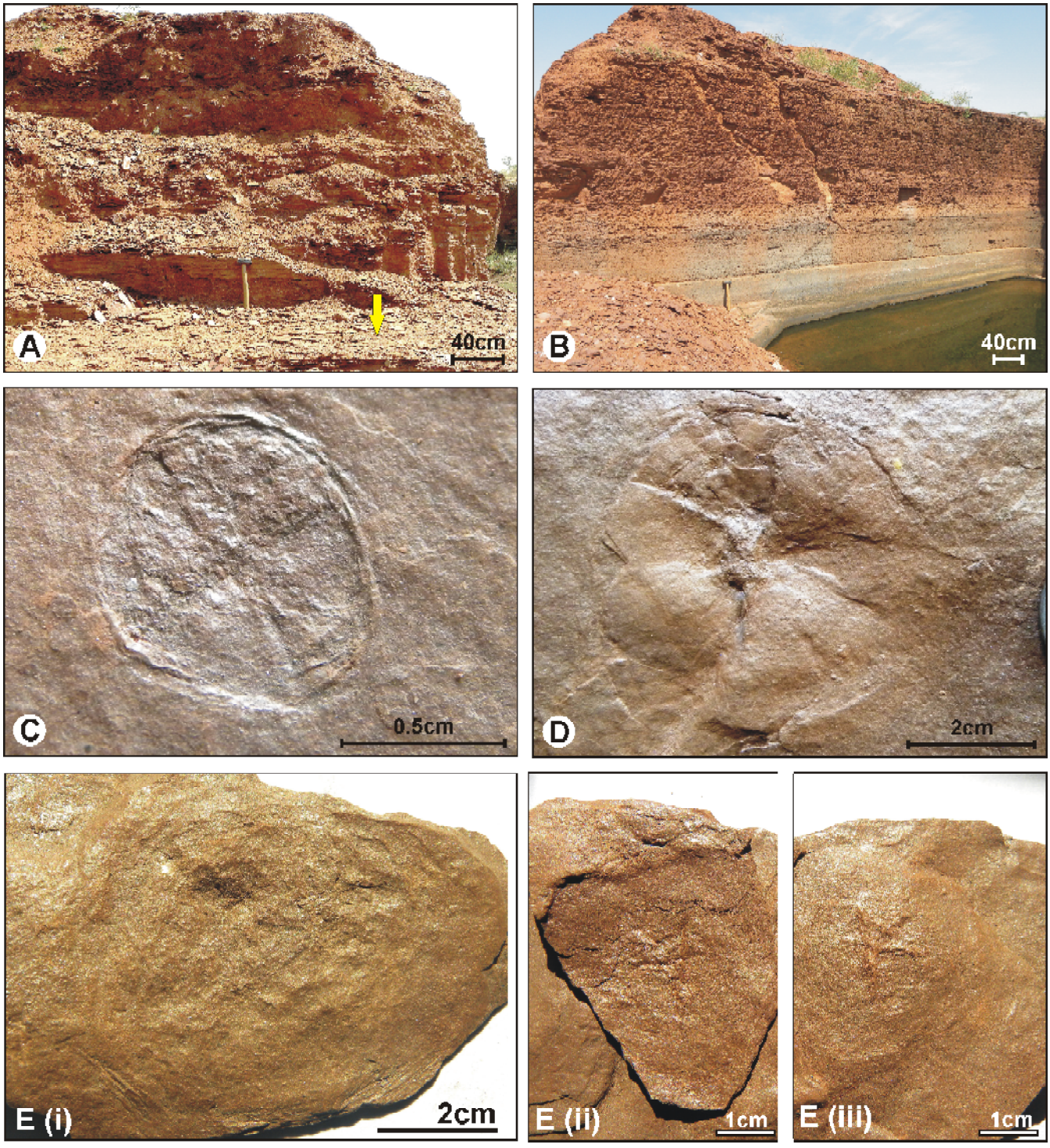

Fig. 4. A, Field photograph of the Jodhpur Sandstone; arrow marks the position of the fossil-bearing horizon. B, Section of the Jodhpur Sandstone (Sonia Sandstone) exposed in a pit near the Artiya Kalan area, district Jodhpur. The lower part is made up of sandstone and the upper part is made up of shale and siltstone which has yielded the fossils. C, *Marsonia artiyansis* shows wrinkled margin at the outer bell with four radial arms originating from the central part of the medusa, Sample no. SK/AK-1. D, Specimen showing smooth outermargin with elevated central disc up to 2mm in height, Sample no. SK/AK-29. E (i), Upper surface of the poorly preserved medusa showing wrinkled outer margin. When sample in E(i) was chipped it yielded a sample E (ii), which on its sole shows marks of the radial arms with negative relief and E (iii) is its counter part which shows arms in positive relief.

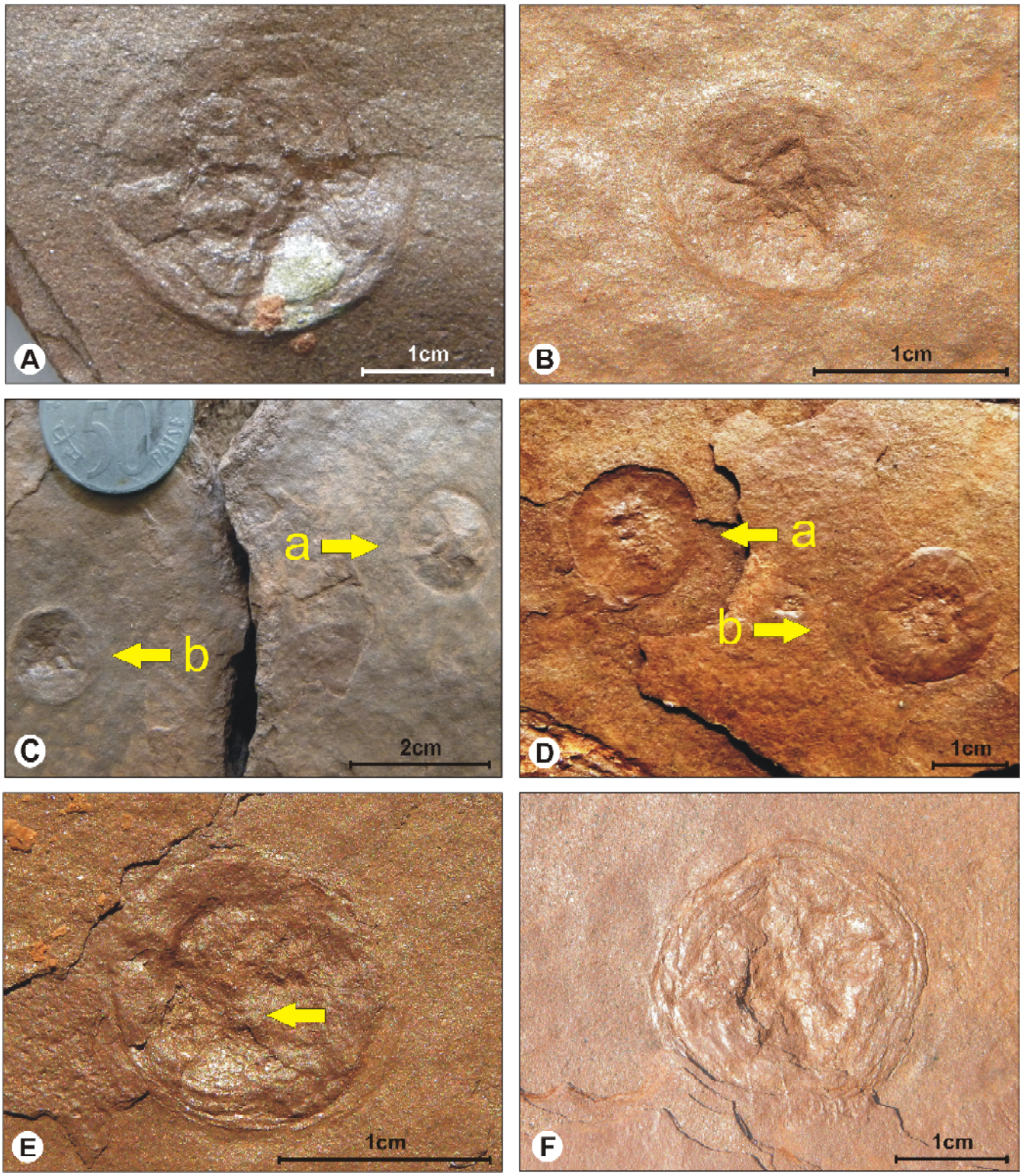

Fig. 5. *Marsonia artiyansis* shows variation in size as well as in the outer margin from smooth to wrinkled. A (sample no. SK/AK-21)-B (sample no. SK/AK-23), Smooth outer margin with dislocated radial arms. C, "a" and "b" are the counter parts of the same specimen; "a" shows raised central part showing central disc with four radial arms; outer margin smooth, sample no. SK/AK-22 a & b. Specimen "b" shows depressed radial arms. D, Specimens "b" is the chipped off part of specimens "a", showing additional circle in the middle and minute central pit at the central part (specimen "b"), sample no. SK/AK-32 a & b. E, Bead-like structure is seen in photograph marked by arrow, sample no. SK/AK-3. F, Specimen showing preservation of many wrinkle layers, sample no. SK/AK-16.

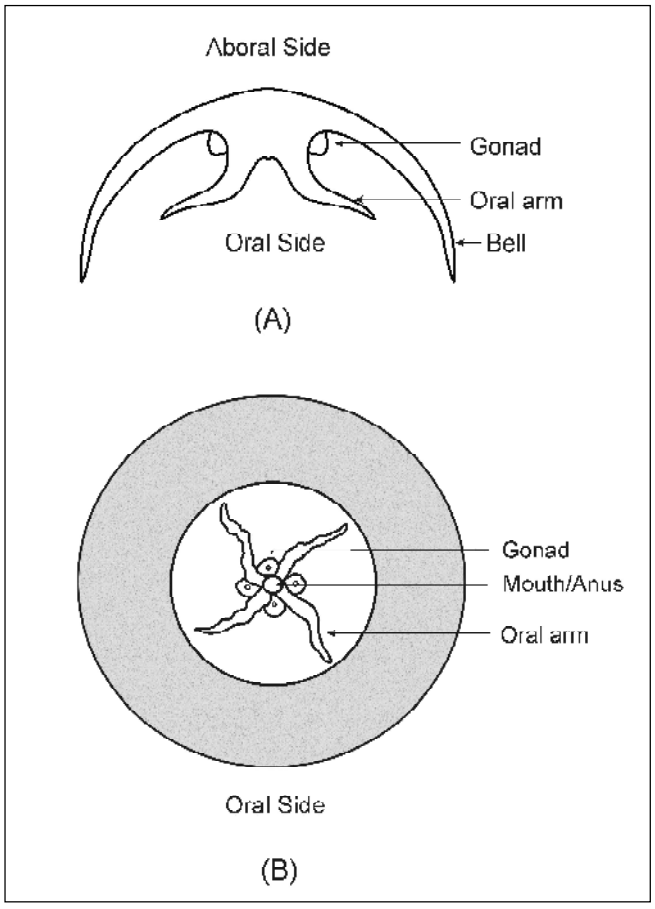

Fig. 6. Simplified sketch of *Marsonia artiyansis*. (A) Longitudinal section of the umbrella or bell. (B) Oral view of the animal showing gonads and oral arms. The shaded area represents the thinner part of the bell.

CONCLUSIONS

In the Ediacaran period (630-542 Ma), the disc shaped fossils described across the globe including USSR, Canada, New Zealand and Australia (Sokolov and Ivonowski, 1985) have been interpreted as belonging to phylum Cnidaria. *Marsonia artiyansis* of the present study has been classed as a medusoid whose morphology compares with the morphology of the forms belonging to class Scyphozoa (Raghav *et al.,* 2005). However, Gehling (2012, personal communication) has expressed his doubts about its affinity with Scyphozoa. Soft bodied nature and lack of hard parts, disc shape morphology, dimensions, presence of beads and arm like structures, central pit, wrinkle marks towards outer margin and nature of preservation in a low energy lagoonal setting points its affinity with a medusoid. In this class all the animals are marine, free swimming and having well developed gastrovascular cavity with large medusa. In lateral view, the fossils described here are somewhat lensoid in shape. In fig.4 E (i-iii) and fig.5 C, D represents the upper and inner parts which clearly suggest that these medusoid forms occur not only on the surface as compressed bodies but also continue deep into the rock body.

The present study supports the interpretations of Raghav *et al.* (2005) for creating a new medusoid genus and species *Marsonia artiyansis* belonging to class Scyphozoa. The study has made modifications in the dimensions of this form and ~~i~~included wrinkles at the margins of the bell as one of the important diagnostic morphological features. Large variation in the morphology is due to taphonomy. There is no evidence for the presence of any frond-like fossils associated with *Marsonia* and it is not preserved in deep-sea deposits. Instead it is preserved in a lagoonal deposit which should not be deeper than a few meters.

When complete forms are preserved, they are likely to produce large-sized forms with wrinkled margins. In case only central part is preserved it is expected to produce smaller forms with smooth margins as shown in the schematic diagram (fig. 6).

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