Probable fossils from Alwar Quartzite, Aravalli Range, North India

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Interesting, lobate, elliptical and raised structures are found on the lower bedding surfaces of Alwar Quartzite exposed on the western limit of the Sohna town, Gurgaon District. These are described and the probability of their being metazoan fossils is discussed.

ROCKS of the Delhi Supergroup[1] form the Proterozoic fold belt in the Aravalli range of India. These have been regarded as Early Proterozoic in age[2,3]. The dating of the granite bodies in the north-east gives higher age ranges (1500–1700 Myr, Rb/Sr isochron)[4] compared to the southeastern part of the belt. The upper part of Alwar Group consists predominantly of quartzite interlayered with phyllite, medium to high grade schists and metavolcanics. Alwar quartzite is well exposed with generally high dips in a series of ridges in Delhi and Gurgaon districts. One such ridge trending westwards from Sohna is formed by folded and steeply dipping, ripple-marked, cross-bedded and feebly graded quartzite, interlayered with garnetiferous schist. The lower bedding surfaces of the quartzite are commonly exposed by the removal of underlying schist layers (2 cm to 2 m in thickness) by weathering. Interesting raised structures are preserved as casts on the lower bedding surface of jointed quartzite separated by schist interbeds. These structures, located near the western limit of Sohna (Figure 1), regarded to be dubiofossils as defined by Hofmann[5], are described here.

Dubiofossil A

(Figures 2.1a,b, 2.2, 2.3a, 3.1, 3.2, 3.3)

Description. Round structures 10–22 cm in diameter with central circular disc having three to four overlapping folds, separated by a deep groove from the sorrounding area, characterized by radially elongate, irregularly bifurcating (0.6 cm high and 0.7 cm thick) ridges, separated by deep clefts arising from the margin of the central disc and continued up to the periphery. Triangular lobes radiating from the central disc broaden out and merge to form an indistinct margin.

Remarks. These round lobate structures are similar to the lobate form recorded from Conception Group in Avlon Peninsula[6]. These have apparent resemblance to *Mawsonites* Glaessner and Wade[7], although they are larger and do not possess the sculpture of large irregular bosses. However, specimens without the sculpture are also recorded from Ediacara Hill, Australia. Interestingly, in one of the structures, close to the central disc a rounded raised structure of the same size is marked by very fine grooving (Figure 2.1a and 2.2). Comparable structures have been described as *Paliella patelliformis* Fedonkin[8], from Vendian, Valdai series, Zimni coast of the White sea and Mogilev Formation (Lomozov Beds), Dniester Basin in Podolia, Eastern European Platform. A form referred to as questionably *Paliella* (Plate 2, Figure 6)[9] exhibits remarkable similarity with the present form. Similar structures have also been described as probable fossils[10] and mechanically formed structures[11]. These structures in Alwar quartzite are regarded as dubiofossils till more convincing material confirming biogenicity is located.

Dubiofossil B

(Figure 3.4a,b)

Description. Concentrically rugose and radially striated disc 16 cm in diameter with subcircular peripheral margin. Surface shows numerous conspicuous striae radiating from the central disc (1.5 cm in diameter) that cross over the annular rugae. The adjacent cast (Figure 3.4b) is dominated by features showing prominent concentric rugae. Faint radial striae can be traced to the centre.

Remarks. These structures have apparent resemblance with *Cyclomedusa gigantea* Sprigg[12], but are relatively bigger in size compared to the Ediacaran medusoid fossil. As such structures can also be formed by fluid motion, these are regarded as dubiofossil B.

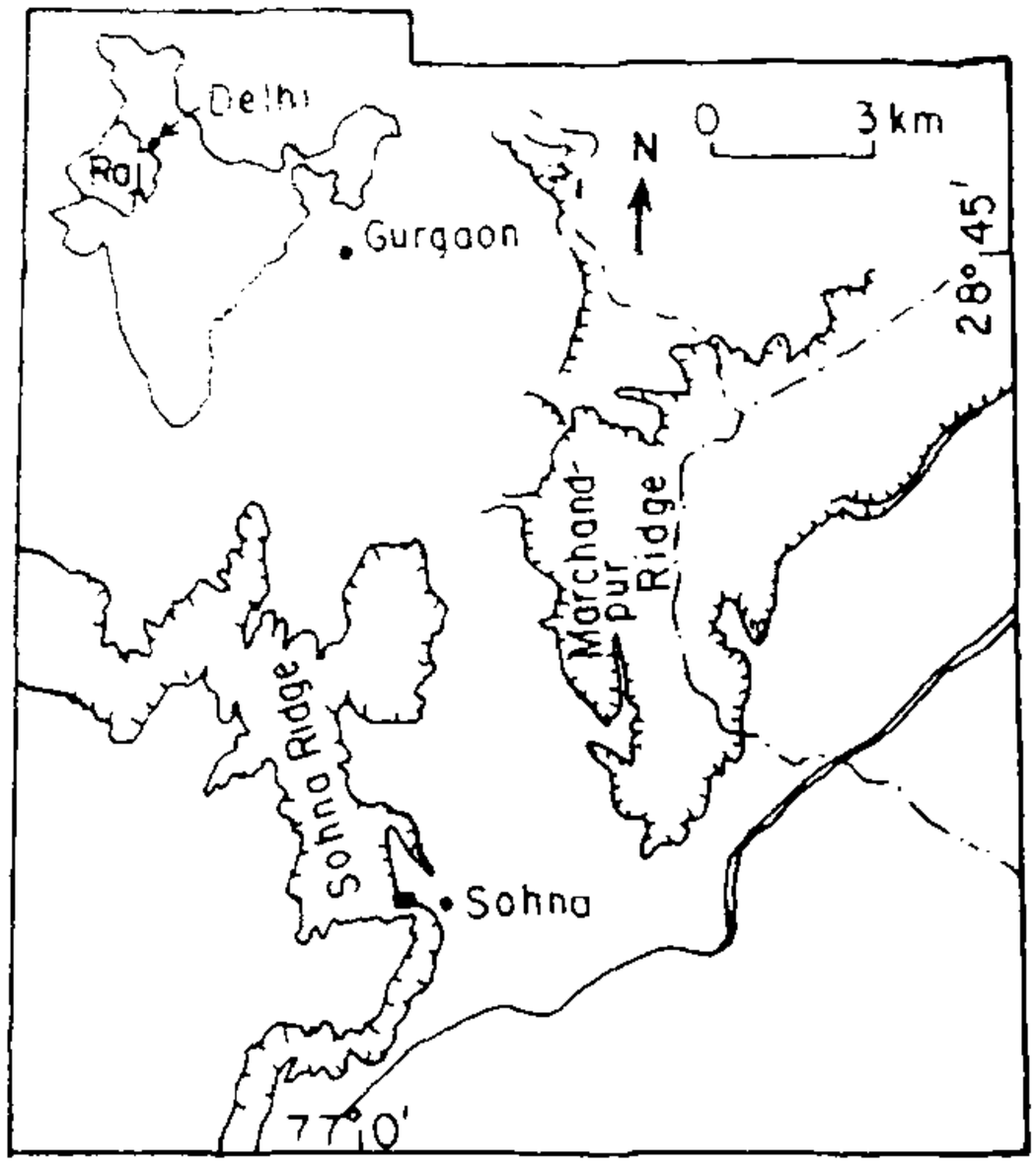
Dubiofossil C

(Figure 2.1c, 2.3b)

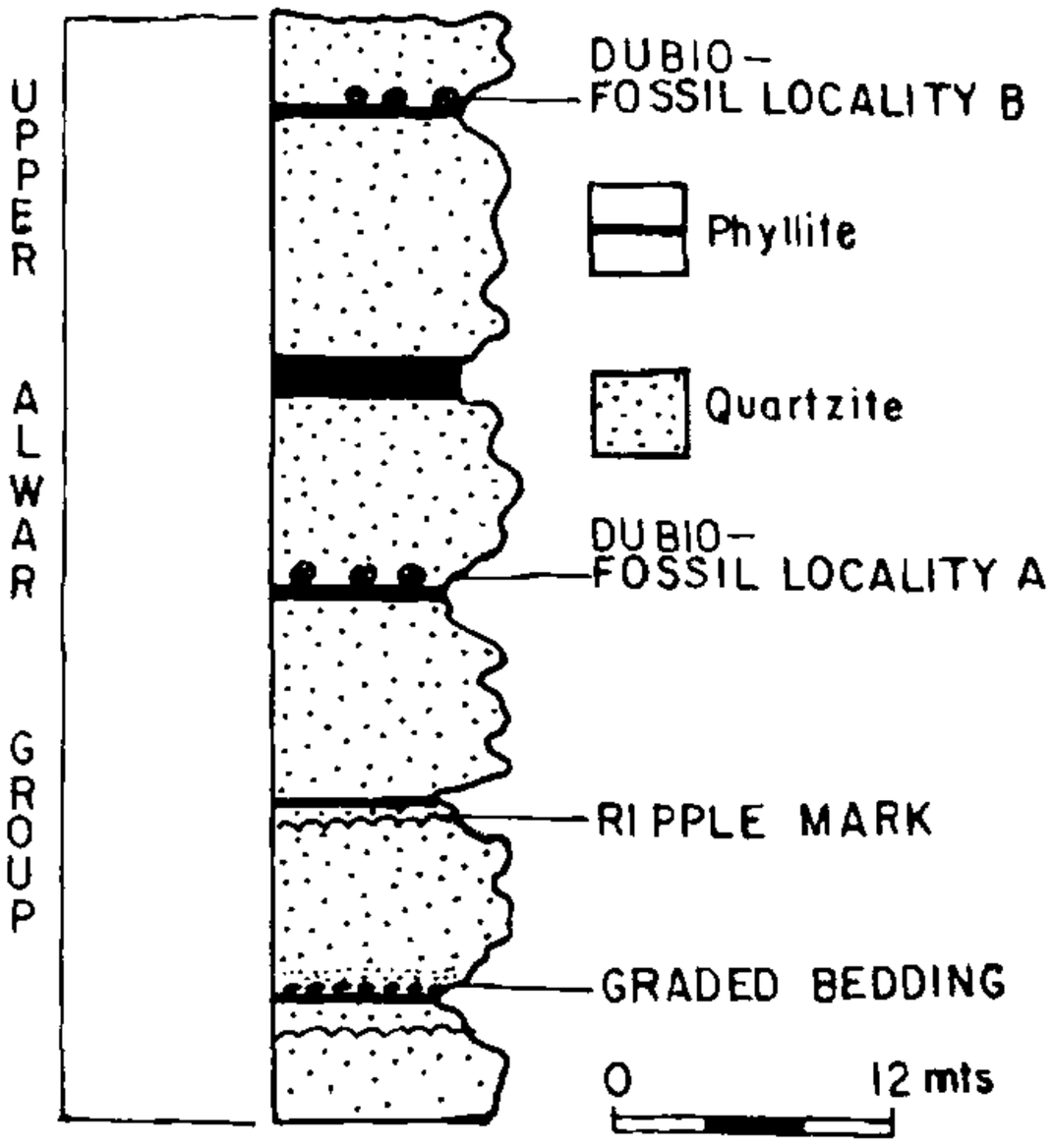
Description. Elliptical structures with four concentric rugae, with long axis parallel to bedding (2.3 cm: 4.2 cm in diameter).

Remarks. This structure apparently resembles exumbrellar view of *Cyclomedusa* Sprigg[13]. It is difficult to identify *Cyclomedusa* in the absence of subumbrellar impression or cast which are characterized by the presence of radial striations. Since concentric rugae can be formed by inorganic processes[14], as well, the structure from Alwar quartzite is presently regarded as dubiofossil.

Discussion These structures have mode of occurrence and appearance similar to the Ediacaran fossils. Structures described here as dubiofossil A, show resemblance to *Mawsonites*. Similar-looking structures were described as probable fossils[10] from a greywacke belonging to the Noltenius Formation of the Finnis River Group, Australia, dated as 2.4 to 1.83 Ga in age[15]. Later, they were reinterpreted as tectonically deformed sand volcanoes[11]. The presence of central



A



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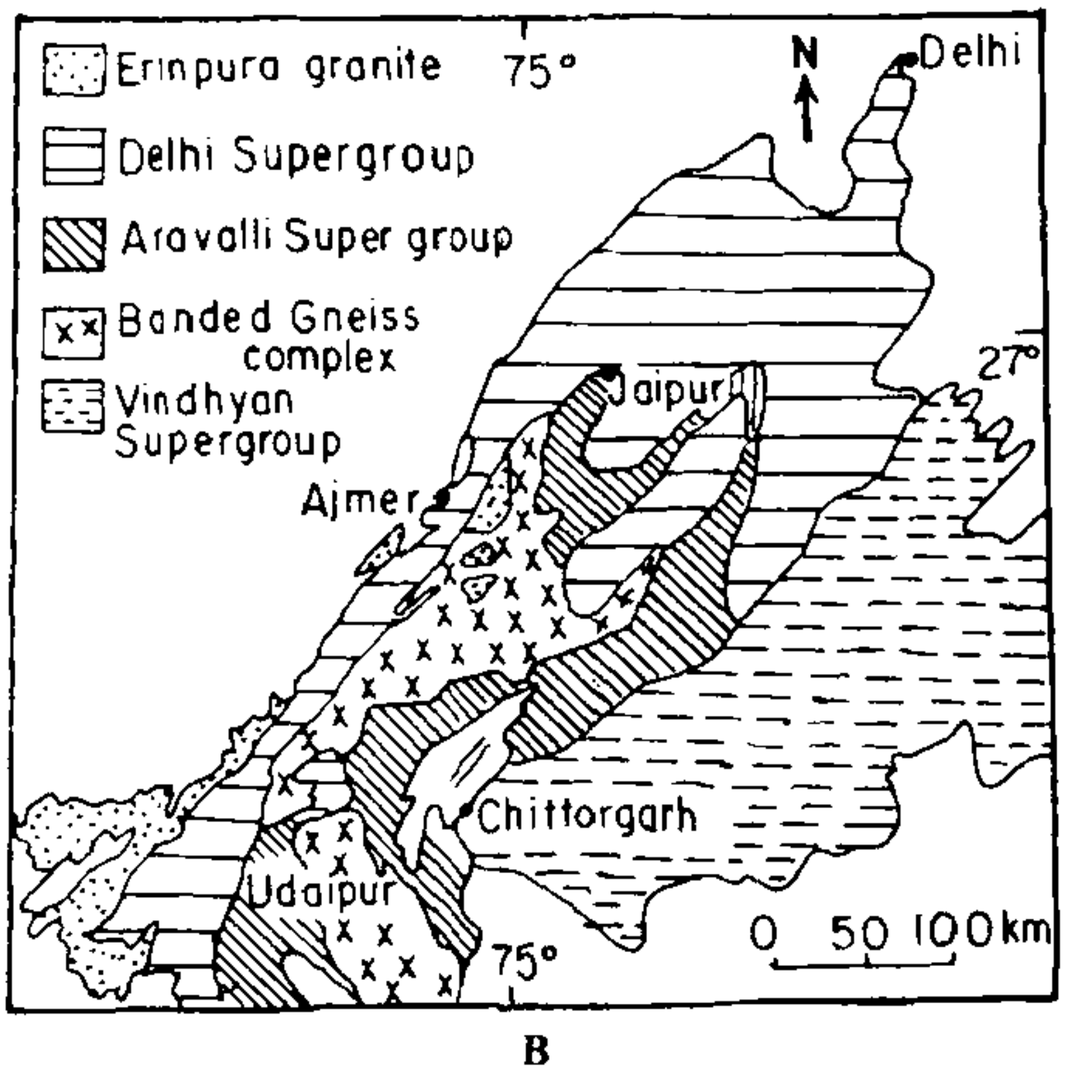

B

Figure 1.A, Locality map. Outcrops of Alwar Quartzite forming the Sohna Ridge. The location of fossil-like structures is marked by solid square. **B**, Geological map of Aravalli Range. **C**, Lithocolumn showing the fossil locality A and B.

concentric grooves, two in number, was regarded to represent the tensional fractures formed by unloading of folding stresses. But the cause of the radial grooving was not understood and explained[11]. Furthermore, many simple-conical structures regarded as sand volcanoes occur on the same bed that bear radially grooved lobate structures in Australia. It is remarkable and difficult to understand how these simple conical 'sand volcanoes' could escape radial fracturing by tectonic deformation. Probably the lobate forms and simple conical forms had different origin and nature of formation. Structures like dubiofossil B resemble *Cyclomedusa gigantea* but are much bigger in size. Dubiofossil C resembles exumbrellar view of *Cyclomedusa*. It is difficult to distinguish *Cyclomedusa* from mechanically formed structures as concentric rugae similar to the exumbrellar surface of *Cyclomedusa* can also be formed by mechanical processes[14].

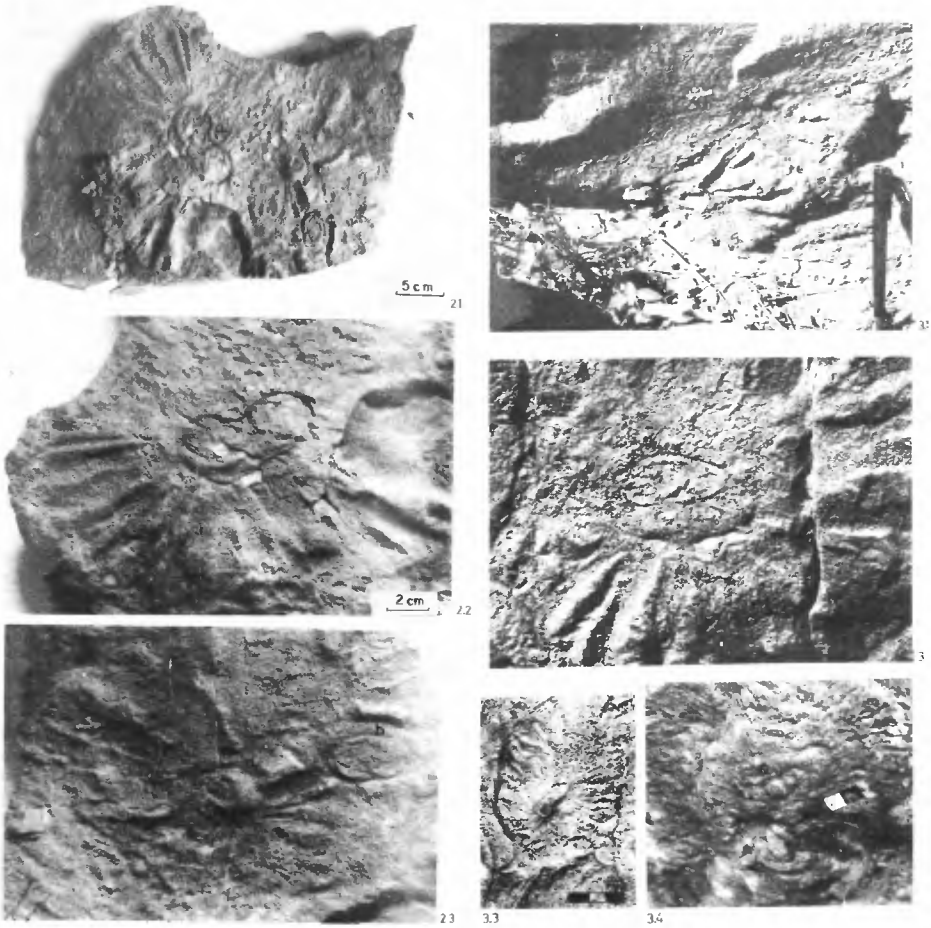

Figure 2. Field photographs of Dubiofossils from Alwar Quartzite. (2.1a, b, 2.2, 2.3a, 3.1, 3.3) Dubiofossil A; (3.4a, b) Dubiofossil B; (2.1c, 2.3b) Dubiofossil C.

The presently recorded structures from Alwar quartzite, exposed in Sohna cannot be interpreted as sand volcanoes because of the following: (i) these occur as raised casts on the lower bedding surfaces of the quartzite overlying schist layers; (ii) there is no suggestion of central vent as the grain size distribution is uniform in the massive quartzite beds. Thus the raised central disc is surfacial and not penetrative; (iii) radial grooves also are not penentrative in nature. Even in Australian examples radial grooves were not revealed in sections across the beds; (iv) simple conical structures are not associated with lobate structures; (v) rare occurrence. These structures are therefore regarded as probable fossils as evidenced by their apparent similarity to Ediacaran forms and absence of convincing explanation for their mechanical mode of formation. If the present find is confirmed by further work as fossils it will be significant in the context of the

origin and antiquity of metazoans.

The record of dubiofossils from Delhi Supergroup regarded as Mid-Proterozoic age[3] is remarkable. The age of Delhi Supergroup is extrapolated as 2000-1500 Myr based on granites[4] in the northern Delhi fold belt. The southern Delhi fold belt with its associated Ennpura granite (Figure 1b) has been dated as 850 ± 50 Myr[16]. A structural discordance between the Delhi Supergroup and pre-Delhi rocks in the southwestern part of the Aravalli belt has been interpreted by some workers[17], while others[18] insist that the Alwar Quartzite cannot be separated from the schists below and no stratigraphic break is discernible between Delhi and Aravalli Supergroups. In the northeastern part, the Delhi rocks unconformably rest over the Banded Gneissic Complex. The duration of the hiatus must be considerable as the pre-Delhi/Delhi contact in the northeastern Aravalli range is represented by a clearly seen unconformity[19]. Northeastern part of the Delhi Supergroup has been regarded as older than Middle Proterozoic[16] as the granite intrusives reveal ages of about 1600 Myr (Rb/Sr isochrons)[3]. There is no precise age data available for the Alwar Group, and although the possibilities of pre-Delhi granitic basement have been expressed[3], it is not likely to fall within the age range of Ediacara fauna. The present record of probable fossils then may either fill the gap between the record of diverse Ediacaran body fossils (680–580 Myr) and the fragmentary record of trace fossils in the 700–900-Myr-old rocks[20] or support the interpretation of forms like *Brooksella canyonensis* recorded from the 1.1–1.36-billion-yr-old Grand Canyon Series as fossils[21] and a longer history of origin and evolution of multicellular organisms[22].

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Effect of barley starch in comparison and in combination with agar and agarose on anther culture of *Hordeum vulgare* L.

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Anthers from barley variety Chernigovski 5 were cultured on N_6 media, gelled with various gelling agents alone or in combination. Higher androgenic calli formation and plantlet regeneration were obtained on medium gelled with agarose than those gelled with agar or agar + barley starch combination. Media gelled with barley starch alone or in combination with agarose were found even more effective than those with agarose alone and also increased the green plant formation significantly. It is suggested that agarose in combination with barley starch can be used successfully as gelling agent for anther culture as this provides firm gel surface throughout, preventing sinking of androgenic calli after enzymatic degradation of starch.

IN anther culture of barley, three media namely MS[1], N_6^2, and potato II[3] are widely employed. A combination of N_6 medium and potato extract has also been suggested[4], but generally erratic and unrepeatable results are obtained on production of androgenic plants due to age, physical condition and variety of potato tubers used. Although agar has been widely used as gelling agent for various anther culture media, it has been shown to contain some inhibitors which result in premature abortion of embryoids in anther culture of tobacco[5].

Among five different types of starch, viz. corn, barley, rice, wheat and potato which were tested as substitute