also hasten the process of utilization of germplasm. It further gives a direction to the effect and practice studies for genetic improvement of this species.


**ACKNOWLEDGEMENTS.** We are grateful to Dr P. G. Rao, Director, NEIST, Jorhat, for providing the necessary facilities while conducting the experiments. S.P.S. thanks the anonymous reviewers for their insightful suggestions and critical reviews.

Received 12 March 2008; revised accepted 22 April 2009

**Mesoprotoreozoic coiled megascopic fossil *Grypania spiralis* from the Rohtas Formation, Semri Group, Bihar, India**

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The present communication records rare megascopic coiled impressions present on a shale slab collected during the recent field work on the Early Mesopro- toreozoic Rohtas Formation of the Semri Group, Vindhyan Supergroup exposed in the Rohtas District, Bihar. The fossil *Grypania* is considered as an important evidence in understanding the evolution of oxygen in the early atmosphere and early experimentation in the biosphere. The present paper also traces the appearance of *Grypania* to the lower part of the Rohtas Formation and adds to our knowledge about the distribution of *Grypania* in the Rohtas Formation.

**Keywords:** Early atmosphere, *Grypania spiralis*, Rohtas Formation, Semri Group, Vindhyan Supergroup.

The coiled megascopic fossil, *Grypania spiralis*, is one of the most important members of the carbonate remains reported from Late Palaeoproterozoic to Mesoprotoreozoic successions of America, China and India. This report adds to a meagre record of *Grypania* in the world, in comparison to the other types of mega-remains, viz. *Chuaria, Tawuia*, Elipsophysid and Moranid remains mostly found worldwide in Mesoprotoreozoic to Neopro- toreozoic successions. Coiled fossils were first described by Walcott* more than a century ago and subsequently reported by different workers. They are interpreted vari-

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CURRENT SCIENCE, VOL. 96, NO. 12, 25 JUNE 2009

1636
ously as representing eukaryotes or large-size prokaryotes. Helically coiled megascopic fossils, *Grypania spiralis*, are known from a few Mesoproterozoic successions of the world. The large size of this fossil is a matter of special interest to Precambrian palaeobiologists. In spite of its rarity in the palaeontological records, this fossil has great significance in understanding the experimentation in the early biosphere. It has also been suggested that the advent of this fossil group represents a distinct level of oxygen evolution in the atmosphere and among the earliest evidence of the existence of eukaryotes on earth. Therefore, each new discovery of the well-preserved fossil *Grypania* is important.

In India, *Grypania* is known only from the Vindhyan basin. In 1919, a solitary fossil spiral impression on a single slab from Saraianpur near Rohtas was reported by Beer from the Rohtas Limestone exposed in Bihar. In spite of painstaking efforts, Beer could not locate another specimen from the area; repeated searches in the following years for helically coiled fossils were without any success. Although the sole occurrence intrigued many palaeontologists, this discovery was well received in the scientific literature since after Walcott's record, it was only the second report of coiled fossils from any other part of the world. However, both the reports were interpreted differently. Originally, the Vindhyan specimen was considered as the impression left by a dead body of a small coiled worm or a track of some small burrowing animal. After restudy, Mathur designated the specimen described by Beer as *Spiroichnus beerii*. Later, from the central part of the Vindhyan basin in Madhya Pradesh (MP), well-preserved, rich assemblages of helically coiled fossils were recorded. Tandon and Kumar originally designated these fossils as *Katnia singhii* and described them as the fossil remnants of an annelid. Subsequently, Kumar considered these as *Grypania spiralis*. Glassner, after examining the Indian specimens from the Katni area supplied by Kumar, concluded that the specimens were large-sized oscillatory filaments. Kumar considered the large size of these helically coiled fossils to represent the phenomenon of gigantism — a natural experimentation in the biotic world. All these helically coiled fossil assemblages were invariably recorded from the Rohtas Formation of the Semri Group of the Vindhyan Supergroup. After nearly 90 years, during the recent field work, another shale slab containing specimens of the fossil *Grypania* was found in the same area where from Beer reported a similar fossil. The present communication records the occurrence of megascopic coiled fossils of *G. spiralis* occurring as impressions in the Rohtas Formation of the Rohtas area. This is the second report of *G. spiralis* from Rohtas District, Bihar. In spite of ideal preservation conditions and stratigraphically correlative strata that yielded abundant *G. spiralis* in central India, their rare occurrence in the Rohtas area is puzzling and presently stands unexplained.

The Vindhyan Supergroup is well exposed in central India. It unconformably overlies the Bundelkhand massif and slightly metamorphosed Bijawar Group (~2500 Ma). The Vindhyan sediments comprise of a thick pile of sandstone, porcellanite, shales and limestone. The entire succession is divided into four groups, namely the Semri, the Kaimur, the Rewa and the Bhandar, in ascending order.

![Figure 1](image-url)
The stratigraphic succession of the Semri Group in the area comprises of the Deoland Formation, Kajrahat Formation, Porcellanite Formation, Kheinjua Formation and Rohtas Formation, in ascending order\(^7\). The Rohtas Formation is exposed along the southern flank of the Vindhyan basin in the Son Valley area. From the Murali
Pahar locality near Dehri (Figure 1 a), the Rampur Shale Member of the Rohtas Formation has yielded *G. spiralis* fossils (Figure 1 b). The Rohtas Formation in the eastern sector of the Vindhyanchal basin has been considered a shallowing upward, increasingly calcareous shale–carbonate interbedded succession developed on an epeiric shelf, whereas the lower part of the Rohtas Formation represents an oxygen-depleted outer shelf\(^2\). U/Pb SHRIMP age dating of the zircon crystals recovered from the ash beds at the top of the Rampur Shale, a lower Member of the Rohtas Formation, has yielded\(^3\) an age of 1599 ± 8 Ma – 1602 ± 10 Ma. The Rohtas Limestone resting gradationally above the Rampur Shale exposed in Bhadanpur area of Maihar, has been considered to be Early Mesoproterozoic, i.e. 1601 ± 130 Ma by Pb–Pb technique\(^4\) while the *Grypania*-bearing Rampur Shale of the Katni area provides 1599 ± 48 Ma age by Pb–Pb technique\(^5\). On the basis of the correlation of strata of the Rohtas Formation exposed in different sectors of the Vindhyanchal basin, it is considered that the Rohtas Formation, including the fossil containing the Rampur Shale Member exposed in the Murali Pahar area, is also ~1.6 Ga old.

The single fossil specimen described earlier by Beer\(^6\) as having a spiral groove with relief, appeared to be a mould. Unlike the specimen recorded by Beer\(^7\) that was preserved as cast and mould, the new set of specimens from Rohtas is preserved as impressions. These structures are present as loose coils and c-shaped forms. These forms have no partings or segmentations, and are of millimetre size. The new occurrence is being formally described here: Division – Incertae sedis; Genus – *Grypania*\(^8\); Type species – *G. spiralis*\(^1\); Locality – Murali Pahar, Rohtas District, Bihar; Stratigraphic position – The Rohtas Formation, Semri Group, Vindhyanchal Supergroup, Early Mesoproterozoic.

*Grypania spiralis* (Walcott) emend. Walter, Oehler and Oehler, 1976 (Figure 2).\(^1\)

Description: Flat, ribbon-like, unbranched impressions preserved on the bedding surface, generally loosely spirally coiled; coil diameter of the ribbon ranges between 0.95 and 1.6 cm, width of the ribbon is 0.9–1.75 mm, length of the ribbon ranges between 0.75 and 6.5 cm; terminations are rare and no segmentations are observed. Impressions are of the same colour as that of the adjacent matrix.

Discussion: Comparable specimens are reported from the Rohtas Formation exposed in Katni area, MP\(^9\), and the Gaoyuzhuang Formation, China\(^10\). Mathur\(^11\) designated the previous specimen described from Rohtas, Bihar as *Spiroichnus beerii*. It was preserved as cast and mould. The specimens recorded from Katni area\(^12\) are preserved on the bedding surface mostly as impressions and a few as possible mould of *Grypania*. In the Katni assemblage, the specimens are tightly to loosely coiled with distinct to indistinct septations. However, the recently found second shale slab has entire specimens preserved as impression and no sepatation has been noted. On the basis of the preservation preference we have categorized the present specimen as *G. spiralis*. This slab was noted in the talus of the freshly excavated, unsuitable shale component of the limestone mine of the Kalyanpur Cements Ltd at Murali Pahar (24°39'20.4"N, 83°58'32.7"E), which was brought to the periphery of the mine for dumping. An extensive search was made for two days in the areas from where the rocks were brought to locate more shale slabs containing similar fossil material. This exercise yielded no success. Though no second slab was found, the specimens on the present slab are described here to put on record the recovery of *G. spiralis* from the locality which yielded an only similar fossil in 1919.

Age – Early Mesoproterozoic.

On the basis of megascopical size of the fossil, *G. spiralis* from Chuar Group was considered by Walter et al.\(^10\) to represent an eukaryotic fossil. On the basis of the size of the biotic remains, Runnegar\(^2\) used *G. spiralis* to estimate the oxygen level of the atmosphere. Similar coiled fossils reported from the Late Palaeoproterozoic from Negamu Iron Formation, Michigan, are considered to be the oldest eukaryotes\(^10\). Limited records of the coiled megascopical fossils and their relevance in determining the ancient oxygen level make each new report an important record in documenting the distribution of *G. spiralis*. *Grypania* is also considered to be the oldest biozone recognizable on the basis of megafossils\(^19\).


ACKNOWLEDGEMENTS. M.S. is grateful to Prof. H. J. Hofmann, McGill University, Canada; Prof. S. Kumar, University of Lucknow and the two anonymous reviewers for constructive suggestions. We thank Dr N. C. Mehrotra, Director, Birbal Sahni Institute of Palaeobotany, Lucknow, for providing infrastructure facilities, encouragement and permission to publish this paper. M.S. is also grateful to Mr S. R. S. Krishnan, President, Kalyanpur Cements Ltd, Rohtas for permission to access the mine areas for sampling, consultation with mine geologist Mr Sanjay Kumar and for providing accommodation. M.S. acknowledges the help rendered by Mr Keshav Ram during fieldwork. This work is partially supported by ILTP Grants sanctioned to M.S. (B 2.56).

Received 19 September 2008; revised accepted 22 May 2009