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Fossils Found in Bikaner Region

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ABSTRACT: Thirteen trace fossils are described from the Nagaur Sandstone, the lower formation of the Nagaur Group. These are Rusophycusdidymus Salter, 1856, Chondrites isp. Brongniart, 1828, Cruziana isp. d'Orbigny, 1842, Isopodichnus isp. Bornemann, 1989, Dimorphichnusobliquus Seilacher, 1955, Monomorphichnusmonolinearis Shah and Sudan, 1983, Diplichnites isp. Dawson, 1873, Skolithos isp. Haldeman, 1840, Palaeophycustubularis Hall, 1847, Planolites isp. Nicholson, 1873, Ichnogenus A, Trails and Scratch Marks . This assemblage has been referred to as the Cruziana assemblage and on this basis the Nagaur Sandstone has been suggested a Lower Cambrian age. Bikaner district. The Nagaur Sandstone has been correlated with the Purple Sandstone of Pakistan, the Tal succession of the Kumaun and Himachal Lesser Himalaya and the Garbyang, Lolab and Kunzum-La Formations of the Tethys Himalaya.

A fossil (from Classical Latin fossilis, lit. 'obtained by digging')[1] is any preserved remains, impression, or trace of any once-living thing from a past geological age. Examples include bones, shells, exoskeletons, stone imprints of animals or microbes, objects preserved in amber, hair, petrified wood and DNA remnants. The totality of fossils is known as the fossil record.

Paleontology is the study of fossils: their age, method of formation, and evolutionary significance. Specimens are usually considered to be fossils if they are over 10,000 years old.[2] The oldest fossils are around 3.48 billion years old[3][4][5] to 4.1 billion years old.[6][7] The observation in the 19th century that certain fossils were associated with certain rock strata led to the recognition of a geological timescale and the relative ages of different fossils. The development of radiometric dating techniques in the early 20th century allowed scientists to quantitatively measure the absolute ages of rocks and the fossils they host.

There are many processes that lead to fossilization, including permineralization, casts and molds, authigenic mineralization, replacement and recrystallization, adpression, carbonization, and bioimmuration.

Fossils vary in size from one-micrometre (1 µm) bacteria[8] to dinosaurs and trees, many meters long and weighing many tons. A fossil normally preserves only a portion of the deceased organism, usually that portion that was partially mineralized during life, such as the bones and teeth of vertebrates, or the chitinous or calcareous exoskeletons of invertebrates. Fossils may also consist of the marks left behind by the organism while it was alive, such as animal tracks or feces (coprolites). These types of fossil are called trace fossils or ichnofossils, as opposed to body fossils. Some fossils are biochemical and are called chemofossils or biosignatures.

KEYWORDS: trace fossils, nagaur, Bikaner, sandstone, succession, Himalaya, assemblage, scratch marks, trails

I.INTRODUCTION

Index

Index fossils (also known as guide fossils, indicator fossils or zone fossils) are fossils used to define and identify geologic periods (or faunal stages). They work on the premise that, although different sediments may look different depending on the conditions under which they were deposited, they may include the remains of the same species of fossil. The shorter the species' time range, the more precisely different sediments can be correlated, and so rapidly evolving species' fossils are particularly valuable. The best index fossils are common, easy to identify at species level and have a broad distribution—otherwise the likelihood of finding and recognizing one in the two sediments is poor.

Trace

Trace fossils consist mainly of tracks and burrows, but also include coprolites (fossil feces) and marks left by feeding.[30][31] Trace fossils are particularly significant because they represent a data source that is not limited to animals with easily fossilized hard parts, and they reflect animal behaviours. Many traces date from significantly earlier than the body fossils of animals that are thought to have been capable of making them.[32] Whilst exact assignment of trace fossils to their makers is generally impossible, traces may for example provide the earliest physical evidence of the appearance of moderately complex animals (comparable to earthworms).[31]

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Coprolites are classified as trace fossils as opposed to body fossils, as they give evidence for the animal's behaviour (in this case, diet) rather than morphology. They were first described by William Buckland in 1829. Prior to this they were known as "fossil fir cones" and "bezoar stones." They serve a valuable purpose in paleontology because they provide direct evidence of the predation and diet of extinct organisms.[33] Coprolites may range in size from a few millimetres to over 60 centimetres.

Transitional

A transitional fossil is any fossilized remains of a life form that exhibits traits common to both an ancestral group and its derived descendant group.[34] This is especially important where the descendant group is sharply differentiated by gross anatomy and mode of living from the ancestral group. Because of the incompleteness of the fossil record, there is usually no way to know exactly how close a transitional fossil is to the point of divergence. These fossils serve as a reminder that taxonomic divisions are human constructs that have been imposed in hindsight on a continuum of variation.

Microfossils

Microfossil is a descriptive term applied to fossilized plants and animals whose size is just at or below the level at which the fossil can be analyzed by the naked eye. A commonly applied cutoff point between "micro" and "macro" fossils is 1 mm. Microfossils may either be complete (or near-complete) organisms in themselves (such as the marine plankters foraminifera and coccolithophores) or component parts (such as small teeth or spores) of larger animals or plants. Microfossils are of critical importance as a reservoir of paleoclimate information, and are also commonly used by biostratigraphers to assist in the correlation of rock units.

Resin

Fossil resin (colloquially called amber) is a natural polymer found in many types of strata throughout the world, even the Arctic. The oldest fossil resin dates to the Triassic, though most dates to the Cenozoic. The excretion of the resin by certain plants is thought to be an evolutionary adaptation for protection from insects and to seal wounds. Fossil resin often contains other fossils called inclusions that were captured by the sticky resin. These include bacteria, fungi, other plants, and animals. Animal inclusions are usually small invertebrates, predominantly arthropods such as insects and spiders, and only extremely rarely a vertebrate such as a small lizard. Preservation of inclusions can be exquisite, including small fragments of DNA.

Derived, or reworked

A derived, reworked or remanié fossil is a fossil found in rock that accumulated significantly later than when the fossilized animal or plant died.[35] Reworked fossils are created by erosion exhuming (freeing) fossils from the rock formation in which they were originally deposited and their redeposition in a younger sedimentary deposit.

Wood

Fossil wood is wood that is preserved in the fossil record. Wood is usually the part of a plant that is best preserved (and most easily found). Fossil wood may or may not be petrified. The fossil wood may be the only part of the plant that has been preserved;[36] therefore such wood may get a special kind of botanical name. This will usually include "xylon" and a term indicating its presumed affinity, such as Araucarioxylon (wood of Araucaria or some related genus), Palmoxylon (wood of an indeterminate palm), or Castanoxylon (wood of an indeterminate chinkapin).[37]

Scientists have unearthed Asia’s first fossil record of mulberry from the Gurha lignite mines near Bikaner in western Rajasthan, a finding that they say, indicates the existence of a warm, humid climate in north-western India 56 million years ago.

Although mulberry (Morus genus) is now widely grown in India and Asia, no fossils of the tree have yet been found in the continent, say a team of scientists from HBN Garhwal University in Uttarakhand, University of Calcutta, and Sidho Kanho Birsa University in Purulia in West Bengal. They report in the journal Review of Paleobotany and Palynology that the presence of the fossil suggests that mulberry was an important component of tropical–subtropical evergreen forests growing in a warm humid climate in the area during the Eocene period, that is, 56-39 million years ago.

According to them, mulberry subsequently declined from the area which is now dry with desert vegetation, probably because of the drastic climate and latitudinal change in the area, related to the formation of the Himalayas, and rainfall seasonality since the Eocene.

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Most mulberry trees are now found in the 'Old World tropics', particularly in Asia and Indo-Pacific Islands.

Mahasin Ali Khan, assistant professor at the department of botany, Sidho-Kanho-Birsha University, and one of the paper authors, told Mongabay India that "to date, no fossil Morus has been reported from Asia."

This lack of fossil evidence limits scientists' understanding of the diversification and evolution of Morus in Asia, Khan says. Leaf and fruit remains of Morus have been reported only from the preceding Palaeocene epoch dating to 66 million to 56 million years ago; and the later 33-million to 23-million-years-old Oligocene sediments of the United States. Hence, the Indian team's discovery of Morus leaf remains from the early Eocene of India "is remarkable" and constitutes the first recognition of this mulberry genus from the Cenozoic (66 million years ago to present) sediments of Asia," their report says.

Earlier fossil studies also indicate a tropical to sub-tropical, warm humid climate in western Rajasthan, unlike present-day dry, desert conditions, the report says.

The equatorial position of the Indian sub-continent during the Eocene period was "ideal" for the growth of tropical evergreen forests, while recovered fossils dating to the Eocene period from lignite mines in western Rajasthan also indicate the presence of tropical rainforests in western India, the report says.

In India, the genus is no longer found in western Rajasthan where the fossil was discovered, and the authors attribute its extinction from the area possibly to "drastic climate change" as well as latitudinal movement in the area as a result of the collision of the Indian and Eurasian plates, uplift of the Himalayas and Tibetan plateau, and evolution, strengthening and long-time fluctuations in the monsoonal conditions.

The scientists hope that the new study "provides a launching pad" for further detailed studies of the newly collected materials, providing a clear picture of their implications.

Scientists are particularly interested in the Eocene period, characterised by warm temperatures, for studies on the evolution, diversity, and dispersal within and among continents of modern-day plant and vertebrate species. While the authors report that the finding of the fossil in the region "provides unambiguous evidence" that mulberry plants were well-suited to the climatic conditions in the Eocene period, not all paleobotanists agree.

Rakesh Mehrotra, president of the Palaeobotanical Society and a scientist with the Birbal Sahni Institute of Paleosciences, Lucknow, says that he does not agree with the conclusions of the study as mulberry "is a temperate genus found naturally in central China and is cultivated in many countries, including India."

"Its presence during the early Eocene in India is doubtful as the fossil flora during the period was typically tropical in nature," says Mehrotra. Fossils recorded during the early Eocene of western India in Bikaner district, including Gurha mine, support his theory, Mehrotra adds.

He points out that the early Eocene is characterised by a warmer phase, even at high latitudes. The carbon dioxide level was also higher, ranging from 1000 to 2000 parts per million (ppm) due to the increase in volcanic activity.

In 2017, Mehrotra and colleagues had published in Review of Paleobotany and Palynology that "the climate dynamics of the Indian subcontinent and biotic exchange between the neighbouring continents can be traced by studying the Eocene fossil assemblages which are nicely preserved in the rock records." Fossil records from early Eocene sites are important for their potential contribution to our understanding of interactions between climate and biota, it said.

In the western part of the Indian subcontinent, extensive lignite deposits are known in Gujarat (Kutch and Cambay basins) and Rajasthan (Barmer and Bikaner-Nagaur basins) specifically Bikaner district. Based on analysis of nearest living relatives (NLRS) of the plant and animal remains in the lignite deposits of these areas, 'it has been concluded that a highly diversified tropical evergreen forest was present in most of the basins of western India," says Mehrotra.

The equatorial position of the Indian subcontinent during the early Eocene also supports this theory, says Mehrotra.

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The lignite mines of Gujarat and Rajasthan have proved to be a rich treasure house of Eocene fossils, pointing towards the existence of dense tropical forests in the arid region of today and equatorial climatic conditions in the Indian subcontinent 55 million years ago.

In 2016, Mehrotra's team reported a rare fossil record of a fruit of Mallotus mollissimus, a plant from the spurge family and whose fruits are too soft to be preserved, from the Gurha mines of Bikaner, Rajasthan. The fossil indicates the existence of tropical forests in the area and the origin of the plant from Gondwanaland.

Similarly, a fossil wood found in the Vastan lignite mine of the early Eocene age near Bikaner, by Mehrotra's team, shows a strong resemblance to the modern genus Chisocheton of the mahogany family of trees known as Meliaceae. Such plant fossils are the best source to reconstruct the past environment of any region, and the locality likely had a "luxurious, highly diverse tropical evergreen forest" in contrast to the tropical thorn forest of the present-day Mehrotra and colleagues' 2017 report in Paleoworld says.

"This early Eocene highly diverse equatorial forest, once covered a significant portion of the Indian subcontinent, is now restricted in fringes known as the Western Ghats in south India attesting to changes in climate," it adds.

Discussion

In the northwest of the Aravalli Mountain Range, the Marwar Supergroup occupies large area in Rajasthan which was earlier referred to as the Trans-Aravalli Vindhyans, (Fig. 1). It is represented by a thick pile of sediments made up of sandstones, shales, carbonates, and evaporites occupying an area of about 51,000 sq. km (Paliwal, 2007). The rocks are unmetamorphosed and undeformed and show excellent preservation of sedimentary structures. The Marwar Supergroup has been subdivided into three groups; in stratigraphic order these are the Jodhpur Group, the Bilara Group and the Nagaur Group which attain a total thickness of more than 1000 m (Pareek, 1984). It unconformably overlies the Neoproterozoic Malani Igneous Suite which has been dated between 780 and 681 Ma (Rathore et al., 1999). The Malani Igneous Suite represents the largest event of anorogenic felsic magmatism in India covering an area of ca 50,000 sq. km. in Rajasthan and Haryana states (Sharma, 2004). The Marwar Supergroup is unconformably overlain by the Permo-Carboniferous Bap Boulder Bed specially in Bikaner district.

Earlier, the Marwar Supergroup was considered unfossiliferous though stromatolites were known since 1964 (Khilnani, 1964). Raghav et al. (2005) recorded for the first time the occurrence of a medusoid fossil Marsonia from the Bikaner Group. A variety of microbial mat structures have now been reported from the Bikaner Group (Sarkar et al., 2008). Kumar and Pandey (2008) announced the discovery of four trace fossils from the Nagaur Group exposed in the Dulmera area, about 65 km from Bikaner on the Bikaner – Ganganagar Road, Bikaner district, western Rajasthan. It helped in suggesting Lower Cambrian age to the upper part of the Marwar Supergroup. The paper presents a detailed work on the trace fossils of the Nagaur Sandstone from the Dulmera area from where Kumar and Pandey (2008) have discovered the trace fossils. It describes thirteen trace fossils and also discusses their stratigraphic significance in correlation.

Fossil trading is the practice of buying and selling fossils. This is many times done illegally with artifacts stolen from research sites, costing many important scientific specimens each year.[115] The problem is quite pronounced in China, where many specimens have been stolen.[116]

Fossil collecting (sometimes, in a non-scientific sense, fossil hunting) is the collection of fossils for scientific study, hobby, or profit. Fossil collecting, as practiced by amateurs, is the predecessor of modern paleontology and many still collect fossils and study fossils as amateurs. Professionals and amateurs alike collect fossils for their scientific value.

Results and Conclusions

The Marwar Supergroup is exposed in the Bikaner–Nagaur–Khatu area in the western Rajasthan .It forms small hillocks and escarpments in a plain desertic setting and as such the exposures are scanty. As mentioned earlier the rocks unconformably overlie the Malani Igneous Suite which has been dated between 780 and 681 Ma (Rathore et al., 1999) and is unconformably overlain by the Permo-Carboniferous Bap Boulder Beds. The Marwar Supergroup has been subdivided into three Groups of Bikaner area. Thirteen trace fossils are described out of which three are informal forms. These are seen both on the top as well as on the sole of the beds in Bikaner. Lithology is represented by fine sandstone and muddy siltstone in Bikaner. Samples are deposited in the Museum of the Centre of Advanced Study in Geology, University of Lucknow, Lucknow, UP, India.

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The use of fossils to address health issues is rooted in traditional medicine and include the use of fossils as talismans. The specific fossil to use to alleviate or cure an illness is often based on its resemblance to the symptoms or affected organ. The usefulness of fossils as medicine is almost entirely a placebo effect, though fossil material might conceivably have some antacid activity or supply some essential minerals.[117] The use of dinosaur bones as "dragon bones" has persisted in Traditional Chinese medicine into modern times, with mid-Cretaceous dinosaur bones being used for the purpose in Ruyang County during the early 21st century.[118]

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