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Some interesting plant fossils from the Mesozoic of the Rajmahal Hills, India

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ABSTRACT

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Description is given of some interesting plant fossils preserved as petrifactions in the Rajmahal Hills, Jharkhand. These are either new and reported for the first time or an additional information is given on already known earlier description. The fossil taxa belong to algae, lichen, gymnosperms and angiosperms.

Key-words—Petrifactions, Cryptogams, Lichen, Angiosperms.

भारत की मीसोज़ोइक युगीन राजमहल पर्वतश्रेणियों से प्राप्त कुछ दिलचस्प पादपाश्म

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सारांश

झारखण्ड की राजमहल पर्वतश्रेणियों के अश्मीभवन के रूप में सुसंरक्षित कुछ दिलचस्प पादपाश्मों का वर्णन प्रस्तुत शोध पत्र में अभिप्रेत है। ये या तो नवीनतम हैं, अथवा प्रथम बार प्राप्त किए गए हैं अथवा इनके माध्यम से पूर्व में वर्णित किए गए पहले से ज्ञात पादपाश्मों के विषय में कुछ अतिरिक्त सूचनाएँ प्रदत्त की जा रही हैं। अश्मित वर्गक शैवाल, लाइकेन, अनावृतबीजियों तथा आवृतबीजियों से सम्बन्धित हैं।

संकेत शब्द—अश्मीभवन, बीजलेख, लाइकेन, आवृतबीजी.

INTRODUCTION

PLANT fossils from the Rajmahal Hills have been known for over a century (Oldham & Morris, 1863). Since then a large number of papers have been published by many workers (Feistmantel, 1877; Sahni & Rao, 1933; Ganju, 1946; Sahni, 1948; Gupta, 1954; Mittre, 1957; Bose & Sah, 1968; Sharma, 1974, 1979, 2000; Banerji, 2000). The bulk of the flora includes fossils of ferns, cycads, Bennettitales, Pentoxylales and conifers. Reports are also available on the occurrence of fossil lycopods, Equisetales, pteridosperms, Ginkgoales and angiosperms (Surange, 1966; Sharma, 1971, 1975, 1997; Banerji, 1990, 1993, 2000a). The plant fossils in the northern portion of the Rajmahal Hills are found mostly as impressions whereas, those in the southern part are petrifactions (Gupta, 1966). Incrustations are rare. In the present paper a few petrifactions collected from Sonajori, Nipania and Amarjola are described. These plant fossils are referable to algae, lichens, pentoxylales, conifers and angiosperms.

MATERIAL AND METHODS

Sonajori is a fossiliferous locality situated 4 km from Pakur (Sharma & Bohra, 1976, 1977) on Pakur-Dumka Road. Intertrappean strata are well distinguished from the thick trap depositions. The chert is silicified. It contains fossils of ferns, Pentoxylales, conifers and angiosperms (Bohra & Sharma, 1979; Banerji, 2000a).

Nipania is a well known locality (Srivastava, 1945; Sahni, 1948; Mittre, 1957; Sharma, 1975a) situated 5 km North west of Amrapara. Fossils are preserved in a hard silicified chert. It shows fossils of ferns, Pentoxyleae, conifers and angiosperms. Amarjola is also a well known locality (Sharma, 1972, 1972a). Here the plant fossils are soft and fragile and are taken out by digging the sandy rock. Ferns, Bennettitales, Pentoxylales, conifers and angiosperms are found at Amarjola (Sharma, 1997, 2000). Isolated petrified short shoots of *Pentoxylon* were collected from this locality. Sections through silicified cherts were cut with the help of a diamond edge wheel, while the soft material from Amarjola was boiled in canada balsam prior to sectioning with the help of a wire band-saw. Slides were prepared by the usual techniques involving grinding and polishing and mounted in canada balsam.

DESCRIPTION

Algae

Dark coloured filaments are seen generally scattered in thin sections prepared through Nipania chert. The filaments are of different sizes and thickness. Each filament has multiseriate siphon-like structure (Pl. 1.1). The siphons are of variable lengths. The superficial ones end into a curved or straight spine-like structures which are actually reduced branches as they have distinct transverse septations. Sharma and Harsh (1994) correlated these filaments with the red alga *Polysiphonia*. It has been observed that the thin sections which have polysiphonous filaments also have numerous globular spores with more or less smooth exine (Pl. 1.2). They resemble typical non-flagellate spores of Rhodophyceae (Bold & Wynne, 1985). However, exact morphology of the associated fertile organs is yet to be described.

Lichens

In a thin section prepared through a piece of Nipania chert is seen an elliptical cross section (Pl. 1.3). It measures 4 x 1.5 mm and has a number of dark coloured bodies of various sizes. The bodies are either solitary or in groups of 2-4. Each has a central cavity of 2-4 cavities surrounded by a thick wall (Pl. 1.4) of variable thickness. The dark coloured bodies are embedded in a ground tissue made up of thin walled narrow filaments which give parenchyma like appearance.

It is believed that the black bodies are phycobionts or algal partner of the lichen, which the ground tissue is mycobiont made up of septate mycelium. In some of the lichens there are special modes of asexual reproduction through soridia and isidia (Bold *et al.*, 1987). These are small propogules in which algal cells are surrounded by the fungal filaments (Bold *et al.*, 1987; fig. 10.5 B, C) as in *Parmelia nudecata*. The present material is probably a cross section through an isidium of some lichen. Further investigations are required on this material.

Gymnosperms

Pentoxyleae short shoots—In *Pentoxylon* the leaves were described to be restricted to the short shoots (Sahni, 1948). The short shoots in general bear closely arranged, small, spiral, rhomboid leaf bases (Sharma, 1975a, 1979a). This observation was based on study of material from Nipania (Srivastava, 1945; Sahni, 1948; Mittre, 1953, 1957). The authors however, were able to collect more than two dozen petrified shoots from Amarjola locality, some of which are figured here (Pl. 1.5). The shoots are of different length and thickness and bear leaf bases of various types i.e., close and rhomboid, close and crescent shaped or sparse and half lunar. They are related to different organs of the pentoxylean plants and performed different function i.e., vegetative shoots, fertile shoots (male & female), etc.

Conifers

Araucarian young roots - Sharma and Bohra (1975, 1980) described an araucarian root *Arauamyelon pakurense* from Sonajori. It has a diarch primary xylem and well developed radial secondary growth. Sharma and Suthar (1989) also

PLATE 1 →

1 Polysiphonous filament of a red alga with lateral spiny out growths. x 48.
2. Scattered spores in association with polysiphonous filaments. x 144.
3. Elliptical cross section of an isidium of a lichen. x 24.
4. Same, a portion enlarged showing dark coloured phycobiont embedded in hyaline mycobiont. x 72.
5. Cross section of an araucarian rootlet. Note thin epiblema, cortex with lamina cells and mycorrhizae (arrows) and diarch xylem with two exarch wide protoxylem points. x 120.
6. Petrified short shoots of Pentoxyleae bearing various types of leaf bases. x 1½.
7 Cross section of a monocot leaf lamina with alternating in a line of smaller and bigger sized bundles (represented as cavities). Lower side adaxial surface, upper side abaxial. x 48.

PLATE 1

described an algal association with the young roots of *Arauamyelon*. In some of the chert pieces from Sonajori araucarian roots are abundant. The present one (Pl. 1.6) is a cross section of a young root of *Arauamyelon*. There is an epiblema layer, 1-2 cells thick of thin walled cells without cuticle. The cortex is 5-6 cells wide with a few dark staining tannin cells. Poorly preserved inter and intracellular mycorrhizae (arrows) is also visible in the cortex. Endodermis is distinct but made up of narrow cells. It encloses a diarch barrel shaped xylem (Pl. 1.6) with two distinct exarch protoxylem points. Xylem is made up of narrow, closely placed thick-walled tracheids (in T.S.). The xylem is 5-6 cells thick in the middle and reduces towards protoxylem points. Phloem is radial and made up of poorly preserved thin walled cells.

From Sonajori chert a number of diarch filician roots have also been described e.g., *Gleichenioamyelon diarcha* Bohra and Sharma (1979), *Filicoamyelon cryptogramoides* Bohra and Sharma (1979), *F. actinosachyoides* Bohra and Sharma (1979). But these are much different from the present araucarian root in the morphology of the cortex, structure of endodermis and the xylem. Banerji (2000) describes more or less a similar cross section from Sonajori chert and identifies it as a fossil lycopod stem *Lycoxylon sonajoriensis* Banerji. She correlates it with *L. indicum* Srivastava (1945) known from the Nipania chert. The latter has a distinct plectostele. A single elliptical xylem plate does not form a plectostele. There should be more than one plate of xylem in order to make a plectostele. The present material is not a stem because leaf bases are absent, the superficial layer of cortex is without cuticle and protoxylem points are exarch, wide and distinct. Presence of mycorrhizae further support under ground portion (may be a root) of the present material. It is a young rootlet of an araucarian root in which neither secondary growth has taken place nor algal association is yet established.

Angiosperm

Monocot leaf—The present material is a cross section of a leaf present in a thin section prepared through a Nipania chert (Pl. 1.7). The two surfaces abaxial and adaxial are quite different from each other. One (abaxial) is straight and is made up of small, narrow rectangular cells while the other (adaxial) is uneven with blunt ridges and furrows resembling those of *Cortaderia selloana* and *Psammochloa villosa* (Metcalfe, 1960). The epidermis of this surface is quite distinct and special, consists of large bulliform-like cells in ridges or raised portions while smaller cells present in the furrows. (The bulliform-like cells were visible in an unmounted slide when examined only in a water film. However, the bulliform cells became invisible on mounting with canada balsam. This feature is common in sections of fossils prepared through Sonajori and Nipania silicified cherts). Probably, the present cross section is of a lamina which had alternating thin and thick veins as is present in many grasses and palms (Metcalfe, 1960; Tomlinson, 1961). The adaxial surfaces of thick veins are covered by bulliform-like cells while narrow veins have smaller epidermal cells.

The mesophyll is undifferentiated into palisade and spongy tissues. It is 2-4 cells thick of small more of less isodiameric cells. The leaf has alternate arrangement in a line of smaller and bigger cavities (probably bundles) in correlation with thin and thick veins respectively (Fig. 1). However, the details of 'bundles' are not preserved and only cavities represent them. In gross morphology the cross section looks of some grass. Further investigations are required on this material.

DISCUSSION

The present investigation supports the earlier findings of polysiphonous filaments and their association with non-flagellate spore. The spores occur not only in large numbers in the chert but are also variable in sizes representing different stages of development. However, cystocarp and other fertile structures are yet to be seen in the Nipania chert. Whether *Polysiphonia*-like plants survived in fresh water lakes of the Rajmahal Hills during the Upper Jurassic or the area had an intrusion of marine water and the red alga came with that from the nearby sea. Venkatachala and Tiwari (1987) have shown marine intrusion and pathway during early Permian through the Rajmahal Hills.

There are not many records of fossil lichens in the world (Taylor & Taylor 1993). If the Fig. 3 identified above as a lichen is correct then this is the first record of a fossil lichen from India and may be from the Mesozoic rocks in the world. In addition to a cross section of an isidium included in the present paper a loose bunch of hyphae and algal cells resembling homoiomerous thallus of a folioge lichen has also been seen in a section through the Nipania chert; description of which will be published elsewhere. Phycobiont is very distinct from the mycobiont. Algal cells are scattered throughout the isidium and no differentiation of a separate cortical portion is visible. This is little different from the isidium of an extant lichens.

Sharma (1973, 1973a, 1974a, 1975a, 1979a, 1996), Suthar & Sharma (1988) and Suthar *et al.* (1988) described the existence of more than one type of short shoots in *Pentoxylon*. A study of external morphology i.e., shape, size and arrangement of leaf bases/bract bases on the surfaces of short shoots collected from Amarjola favour the above statement. It is however, difficult at present to correlate them with their functions like photosynthesis, reproduction, etc. At the same time while suggesting their relationships we must keep in mind that in addition to *Pentoxylon* allied stems-like *Guptioxylon* Sharma (1969) and *Purioxylon* Sharma (1971) are also found at Amarjola.

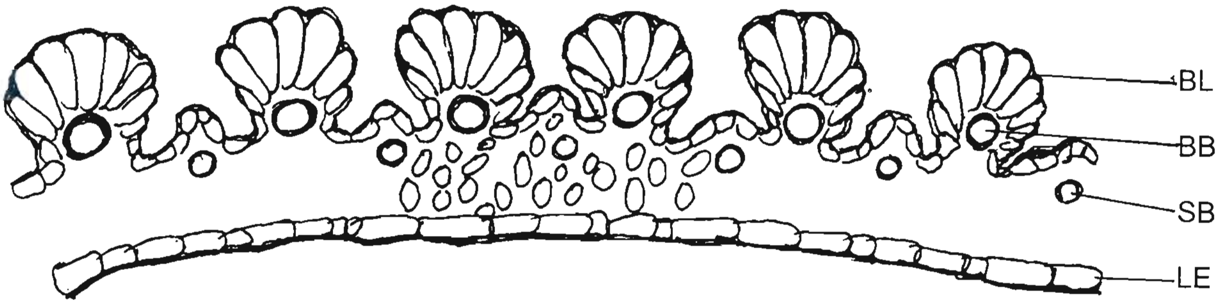

Fig. 1—Cross section of a monocot leaf lamina. Note bulliform-like cells on the adaxial surface with the bigger sized bundles in ridges while furrows have smaller sized epidermal cells. x 60. (BL - Bulliform cells, BB - Bigger bundle, SB - Smaller bundle, LE - Lower epidermis).

The araucarian roots occur frequently in Sonajori chert. These are diarch with many cells containing dark contents in cortex. Secondary growth (Sharma & Bohra, 1975, 1980) is normal except in roots which have algal association (Sharma & Suthar, 1989), a condition identical to the coralloid roots of *Cycas* (Pant, 1973). Some of the young rootlets neither have the secondary growth nor an association of an alga. On the other hand they may show mycorrhizae in their cortical portion, as is seen in the present material. Banerji (2000) identifies a cross section resembling the present figure 6 as *Lycoxylon sonajoriensis* Banerji. It is neither a stem nor similar to *Lycoxylon indicum* and a reconsideration is required.

During recent years a number of fossil angiosperms (Pollen grains and mega-fossils) have been reported from the Rajmahal Hills (Mittre, 1956; Sharma, 1997; Tripathi & Tiwari, 1991; Tiwari & Tripathi, 1995; Banerji, 2000, 2000a). All of them are dicots. But the present leaf has association with monocots. It has alternating thick and thin veins, a character found in the lamina of many grasses and palms. The presence of bulliform-like cells in the adaxial epidermis further supports the monocot angiosperm nature of the present material (Metcalfe, 1960; Tomlinson, 1961; Easu, 1965). A number of sections prepared through the Nipania chert bear cross sections of leaves resembling arecoid palms; descriptions of which will be published else where. The present investigation suggests that both dicots and monocots had already appeared during the Upper Jurassic/Lower Cretaceous in the Rajmahal Hills but with a very low frequency and restricted distribution. The fossil flora of the Rajmahal Hills is not exhausted and needs continuous investigations.

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