

# Reappraisal of Athgarh flora with remarks on its age

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Mega and microfossil data from the Athgarh Formation in Mahanadi Basin is evaluated for correlation of fossiliferous beds. The mega plants show the dominance of pteridophytes and conifers and rare occurrence of cycadophytes. The genera *Gleichenia*, *Hausmannia*, *Phlebopteris*, *Onychiopsis*, *Cycadopteris*, *Brachyphyllum*, *Pagiophyllum*, *Araucarites* and *Elatocladus* are important constituent of the flora. The *Araucariacites-Callialasporites* pollen complex along with megaspores, *Murospora*, *Paxillitriletes* and *Lametatriletes* (=in situ spore of *Weichselia*) are recorded from Athgarh Formation. The comparison and correlation of flora with the floral assemblages of other basins of India show that Athgarh Formation represents an Early Cretaceous sequence in Mahanadi Basin and may be an eastern extension of Bansa Flora of Jabalpur Formation. The environment under which the sediments deposited was fluvio-lacustrine.

**Key-words**—Palaeoflora, Athgarh Formation, Mahanadi Basin, Early Cretaceous.

## INTRODUCTION

THE Upper Gondwana sediments are exposed in isolated patches along the East-Coast of Indian Peninsula. The sedimentary sequences occurring at the northern most part of the East-Coast belong to Athgarh Formation (Athgarh Sandstone) in Mahanadi Basin, Orissa. The formation is named after the village Athgarh (20°30'N : 85° 41'E) and covers an area of about 600 sq. km. The Athgarh Formation rests unconformably over Precambrian basement. But palynological records from the olive green shales (Tiwari *et al.* 1987) confirm the occurrence of Talchir beds, underlying Athgarh Sandstone. Blanford *et al.* (1859) for the first time used the term 'Athgarh Basin' and demarcated the area on the basis of sedimentary outcrops. Ball (1877) reinvestigated the stratigraphy of the region and pointed out the occurrence of coal and collected few plant fossils from Ghantikhal, that were described by Feistmantel (1877). In recent years Adhyalkar and Rao (1963), Pandya and Patra (1968), Jain (1968), Patra (1973a, b, 1980, 1989), Patra and Patnaik (1974), Patra and Sahoo (1992, 1995) carried out significant work in the area. Palynological studies have been dealt by Maheshwari (1974), Jana and Tiwari (1986), Jana (1990) and Jana and Ghosh (1997). The palaeofloral assemblages indicate homotaxiality with the contemporaneous sequences of India and help in determining the geographical distribution of important fossil taxa during Early Cretaceous.

The sedimentary sequences are about 400 m thick (Kumar & Bhandari 1973), comprising of Athgarh sandstone with intercalations of shales and clays along with conglomerate and fire clay. Plant fossils are mostly recovered from pinkish white or yellowish brown shales of Ghantikhal, Naraj and Talbast localities. The other outliers at Dhurusia, Rautrapur and Bouda are situated north of Mahanadi, while Sidheshwar, Badathali Mundia, Jagat Mundia, Jagannath Prasad quarry and Kuspangi are situated south of Mahanadi River.

## MEGAFOSSILS

The Athgarh floral assemblage is rich in pteridophytes and conifers, whereas cycadophytes are comparatively less. Pteridosperms, caytoniales and ginkgophytes are rare in occurrence. Plant fossils reported from the Athgarh Formation are listed below:

### Pteridophytes

*Equisetites rajmahalensis*, *Equisetites* sp., *Marattiopsis macrocarpa*, *Gleichenia nordenskioldii*, *G. gleichenoides*, *Gleichenia* sp. cf. *G. boshai*, *Gleichenia* sp., *Todites indicus*, *Coniopteris hymenophylloides*, *C. burejensis*, *Coniopteris* sp., *C. quinqueloba*, *Coniopteris* spp. A & B, *Haydenia* sp., *Hausmannia* sp., *Eboracia lobifolia*, *Dicksonia* sp., *Matonidium* sp., *Phlebopteris athgarhensis*, *P. polypodioides*, *Phlebopteris* sp. cf. *P. athgarhensis*, *Phlebopteris*

spp. A & B, *Cladophlebis indica*, *C. denticulata*, *C. nebbensis*, *C. ankazoaboensis*, *C. medlicottiana*, *C. srivastavae*, *C. acutipensis*, *C. kathiawarensis*, *Cladophlebis* sp. cf. *C. haiburensis*, *Cladophlebis* sp. cf. *C. longipensis*, *Cladophlebis* sp. cf. *C. reversa*, *S. otagoensis*, *Sphenopteris* spp. A & B, *Rhizomopteris ballii*, *Rhizomopteris sahnii*, *Onychiopsis* sp. cf. *O. paradoxus*, *Onychiopsis psilotoides*, *Onychiopsis* sp. and *Spiropteris* (Fern rhizome).

#### Pteridosperms

*Pachypteris indica*, *Pachypteris* sp. and *Thinnfeldia* sp.

#### Bennettitales

*Nilssoniopteris* sp., *Anomozamites fissus*, *Ptilophyllum acutifolium*, *P. cutchense*, *P. oldhamii*, *P. indicum*, *P. sahnii*, *Ptilophyllum* sp., *Otozamites penna*, *Otozamites* sp. cf. *O. kachchhensis*, *Dictyozamites* sp., *Pterophyllum kingianum* and *Pterophyllum* sp. cf. *P. distans*.

#### Cycadophytes

*Pseudoctensis* sp., *Taeniopteris spatulata*, *Taeniopteris* sp. and *Cycadites* sp.

#### Conifers

*Araucarites cutchensis*, *A. macropterus*, *A. nipaniensis*, *A. sehoraensis*, *A. mimutus*, *Araucaria pantiana*, *Pagiophyllum magnipapillare*, *P. peregrinum*, *P. grantii*, *Pagiophyllum* sp. cf. *P. marwarensis*, *Pagiophyllum* sp., *Brachyphyllum rhombicum*, *B. expansum*, *B. mammillare*, *B. kendalium*, *B. regularis*, *Desmiophyllum indicum*, *Elatocladus plana*, *E. tennerimus*, *E. conferta*, *E. jabalpurensis*, *Podozamites lanceolatus*, *Stachyotaxus elegans* and *Coniferocaulon rajmahalense*.

### PALYNOFLORA

The palynological studies are mainly carried out from Sidheswar Hill, Jagannath Prasad and Talbast quarries.

*Cyathidites australis*, *C. minor*, *C. cutchensis*,

*C. ghuneriensis*, *C. asper*, *Cyathidites* sp., *Deltoidospora* sp., *Dictyophyllidites harrisii*, *Todisporites minor*, *Todisporites* sp., *Alsophilidites bellus*, *Concavisporites indicus*, *C. crassus*, *C. novicus*, *Concavisporites* sp., *Concavissimisporites crassatus*, *Concavissimisporites* sp., *Osmundacidites wellmanii*, *Osmundacidites* sp., *Pilososporites* sp. cf. *P. notensis*, *Foveosporites* sp., cf. *F. canalis*, *Foveosporites* sp., *Lycopodiumsporites austroclavatidites*, *L. circolumenus*, *L. subtriangulus*, *Lycopodiacidites* sp., *Boseisporites insignitus*, *B. minutus*, *B. praeclarus*, *Boseisporites* sp., *Matonisporites kutchensis*, *Matonisporites crassiangularatus* *Matonisporites* sp., *Properipollenites monoalaeusporus*, *Cedripites nudis*, *Alisporites haradensis*, *Impardecispora indica*, *I. uralensis*, *I. apiverrucata*, *Impardecispora* sp., *Cicatricosisporites ludbrookii*, *Cicatricosisporites* sp., *Neoraistrickia pallida*, *Neoraistrickia* sp., *Verrucosisporites* sp., *Reticulatisporites pudens*, *Trilobosporites trioreticulatus*, *Lametatriletes indicus*, *Murospora florida*, *Murospora* sp., *Paxillitriletes* sp., *Podosporites tripakshi*, *Klukisporites areolatus*, *K. pseudoreticulatus*, *Ischyosporites crateris*, *Gleicheniidites circinidites*, *Densoisporites velatus*, *Monoletes indicus*, *Contignisporites fornicatus*, *C. glebulentus*, *C. dettmannii*, *Lakhnavitriletes bansaensis*, *Aquitriradites spinulosus*, *Callialasporites trilobatus*, *C. triletus*, *C. segmentatus*, *C. indicus*, *C. punctatus*, *C. döringii*, *C. enigmatus*, *Classopollis classoides*, *C. indicus* *Crassimonoletes surangei*, *Araucariacites nudis*, *A. australis*, *A. cooksonii*, *A. ghuneriensis*, *A. limbatus*, *Podocarpidites novus*, *P. ellipticus*, *P. vermiculatus*, *Vitreisporites pallidus*, *Microcachryidites antarcticus*, *Cycadopites couperi*, *Monosulcites ellipticus*, *Classopollis indicus*, *Monolites intragranulosus*, *M. indicus*, *Coptospora* sp. and *Abiespollenites* sp.

### DISCUSSION

Floristically, Athgarh assemblage is coeval to the Bansa floral assemblage of Jabalpur Formation. Both the floras show high diversity of pteridophytes with

common representation of *Phlebopteris*, *Gleichenia nordenskioldii*, *Onychiopsis* and *Hausmannia*. *Allocladus* and *Weichselia* have not been reported from Athgarh, although *Lametatriletes indicus* (= *in situ* spore of *Weichselia reticulata*) has been reported by Singh and Venkatachala (1988).

The Sehora flora of Jabalpur Formation is also characterized by the abundance of cycadophytes, conifers and pteridosperms but differs in meagre occurrence of ferns. Therefore, Athgarh floral assemblage does not match with Sehora flora.

The Early Cretaceous floras of Himmatnagar, Gardeshwar and Dhrangadhra of Gujarat are coeval in the presence of common forms e.g. *Gleichenia nordenskioldii*, *Brachyphyllum regularis*, *Hausmannia*; however, *Matonidium* and *Allocladus* have not been recorded in Athgarh flora.

The Rajmahal floral assemblage comprising of broad-leaved cycadophytes and pentoxylae group of plants, are not represented in Athgarh Formation. The palynoassemblage studied by Tiwari and Tripathi (1995) shows similarity in having gymnosperm pollen *Araucariacites* in association with *Podocarpidites* in palynozone 'O' of Intertrappean beds (Early Cretaceous) of Rajmahal Basin.

Singh (1966) reported characteristic Early Cretaceous palynofossils from Satpura Basin where *Araucariacites*, *Callialasporites*, *Podosporites* and *Vitreisporites* are common with the mioflora of Athgarh formation. Maheshwari (1974) recorded palynofossils from Bansa, South Rewa Basin, and found *Araucariacites*, *Callialasporites*, *Microcachryidites*, *Ischyosporites*, *Gleicheniidites*, *Impardecispora* and *Monoletes* as common palynofossils.

While assessing the megafloral records Feistmantel (1877) correlated Athgarh Sandstone with Rajmahal Formation and assigned Liassic age. Ball (1877) considered that the shales of Sidheshwar Hill are equivalent to the Intertrappean beds of Rajmahal Formation. Pascoe (1959) considered carbonaceous shales of Sidheshwar Hill equivalent to Barakar beds, but absence of characteristic Damuda fossils and

presence of *Cladophlebis* and *Marattiopsis* in light coloured clay bed, overlying the carbonaceous shale, show its affinity with Rajmahal flora. Patra (1973a, b) on the basis of plant mega fossils suggested Upper Jurassic-Lower Cretaceous age between Rajmahal and Jabalpur. Sukh-Dev (1988) proposed twelve floristic zones for Mesozoic flora of India. Among them, the Assemblage Zone-10 (Early Cretaceous), is characterized by the occurrence of *Weichselia-Onychiopsis-Gleichenia*, rich pteridophytes and conifers with paucity of cycadophytes and pteridosperms. Accordingly, Athgarh was assigned Early Cretaceous (Aptian-Albian) age. Prakash and Sukh-Dev (1994) also supported an Early Cretaceous age for the flora. On the basis of dominance of *Callialasporites* and *Araucariacites* in Athgarh Formation, Maheshwari (1975) assigned Upper Jurassic – Early Cretaceous age but Jana and Tiwari (1986) assigned Upper Jurassic age. Singh and Venkatachala (1988) reassessed the palynoflora and pointed out the occurrence of *Ischyosporites*, *Impardecispora*, *Klukisporites*, *Sestrosporites* and *Contignisporites* in Athgarh Formation and suggested Early Cretaceous age. Jana and Ghosh (1997) reported the megaspore with the dominance of *Paxillitriletes* which is a characteristic form of Early Cretaceous in Netherlands, Canada and England. Singh (1983) reported spores of *Paxillitriletes* from Cenomanian beds of Canada. The faunal evidences from Athgarh Formation are not known. The available data of megafossil, miospores and megasporer strongly favour the Early Cretaceous age (Neocomian) date for Athgarh Formation.

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