

A basal Gondwana palynoflora from the glaciogene sediments of Tatapani-Ramkola Coalfield, India

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ABSTRACT

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Palynological studies were undertaken on the sediments of Talchir Formation exposed along a stream cutting in the Tatapani-Ramkola Coalfield, Chhattisgarh State, India. The glaciogenic nature of the Talchir Formation is evident, as manifested by the presence of lithified tillites, varves and rafted boulders. The varve clays have yielded a well preserved assemblage rich in radial monosaccates. The assemblage is dominated by *Plicatipollenites* (26-31%) with a sub-dominance of *Parasaccites* (8-22%). *Potoniopsisporites*, *Virkipollenites*, *Caheniasaccites* and *Sahnites* are the other important constituents. The recovered palynoflora is characteristic of *Plicatipollenites-Parasaccites* palynoassemblage, which represents Lower Talchir palynozone and is of early Permian age.

Key-words—Gondwana, Palynology, Talchir Formation, Early Permian, Tatapani-Ramkola Coalfield.

तातापानी-रामकोला कोयलाक्षेत्र, भारत के ग्लेसीजीन अवसादों से प्राप्त एक आधारित गोंडवाना परागाणुवनस्पति-जात

रतन कर

सारांश

तातापानी-रामकोला कोयलाक्षेत्र, छत्तीसगढ़ राज्य, भारत में सरिता कर्तन के सहारे अनावरित तल्वीर शैलसमूह के अवसादों के परागाणविक अध्ययनों का जिम्मा लिया गया। शिलीभूत टिलाइडों, अनुवर्षस्तरी व चाटी गोलाशम की विद्यमानता से यथा सुस्पष्ट तल्वीरशैलसमूह की ग्लेसीजेनिक प्रकृति साक्ष्य है। अनुवर्षस्तरी मृत्तिका से त्रिज्य एकलसपुटी में प्रचुर सुपरिभक्षित समुच्चय मिली है। समुच्चयों *रासैक्काइडिस* (8-22 प्रतिशत) की उप-प्रभुत्वता सहित *प्लिकेटिपोल्लेनाइडिस* (26-31 प्रतिशत) से प्रभावी है। *पोटोनियाइसपो राइडिस*, *विकीपोल्लेनाइडिस*, *कहेनियासेक्काइडिस* एवं *साहनाइडिस* अन्य महत्वपूर्ण अंतर्वस्तुएं हैं। प्राप्त परागाणु वनस्पति-जात *प्लिकेटिपोल्लेनाइडिस-पैरासेक्काइडिस* परागाणु समुच्चय की विशेषता है जो निम्न तल्वीर परागाणुमंडल एवं प्रारंभिक पर्मियन काल का द्योतक है।

संकेत-शब्द—गोंडवाना, परागाणुविज्ञान, तल्वीर शैलसमूह, प्रारंभिक पर्मियन, तातापानी-रामकोला कोयलाक्षेत्र।

Uma Palinoflora Gondvânica basal dos sedimentos glaciogenos do Hulhífero Tatapani-Ramkola, Índia

RESUMO

Estudos palinológicos foram realizados nos sedimentos da Formação Talchir, exposta ao longo da margem de um córrego no Hulhífero Tatapani-Ramkola, Estado de Chhattisgarh, Índia. A natureza glaciogênica da Formação Talchir é evidenciada pela presença de tilitos litificados, varvitos e matações estriadados. As argilas várnicas produziram uma assembléia bem preservada, rica em grãos de pólen monosacados radiais. A assembléia é dominada por *Plicatipollenites* (26-31%), com um subdomínio de *Parasaccites* (8-22%). Outros constituintes importantes são os *Potoniopsisporites*, *Virkipollenites*, *Caheniasaccites* e os *Sahnites*. A palinoflora obtida é característica da palinoassembléia *Plicatipollenites-Parasaccites*, que representa a palinozona Talchir Inferior e é de idade eopermiana.

Palavras-chave—Gondwana, Palinologia, Formação Talchir, Eopermiano, Hulhífero Tatapani-Ramkola.

INTRODUCTION

Extensive deposits of Gondwana sediments occur in peninsular India along several well defined rectilinear belts. The Gondwana basins are demarcated by boundary faults having graben or half-graben structure and are located along major river valleys. The initiation of Gondwana sedimentation in all the basins is marked by glacial deposits named as the Talchir Formation. As in the other Gondwanaland continents, the deposition of sediments of the Talchir Formation is supposed to have begun during Late Carboniferous (Pascoe, 1968). The Geological Survey of India, which is the pioneering and premier organization engaged in geological mapping in the country, and has done extensive mapping of the Gondwana sequences, also places the base of Talchir Formation at terminal Carboniferous (Mukhopadhyay *et al.*, 2010). However, due to the absence of marker late Carboniferous fossils, the age of the Talchir Formation has been placed at early Permian (Tiwari, 1996; Tiwari & Tripathi, 1992). Though good deposits of Talchir sediments occur in all the coalfields, palynological records of such sediments are few and far between. This is primarily because the sediments are basically non-carbonaceous in nature and hence poor in pollen-spores. Moreover, with more focus on the coaliferous formations of the Gondwana Sequence, the sediments of the Talchir Formation received little attention with regards to palynological delimitations. The present communication is an attempt to look at the palynoflora occurring at the basal part of the Gondwana Sequence, from the glaciogene sediments of the Talchir Formation, exposed at a stream cutting in the Tatapani-Ramkola Coalfield, Chhattisgarh, India.

AREA OF STUDY

The Tatapani-Ramkola Coalfield is the western most extension of the Damodar-Koel Valley Basin. The coalfield is a composite basin and comprises a northern strip of coal bearing sediments named as Tatapani Coalfield, while the southern group of rocks is referred as the Ramkola Coalfield. The former is so named because of a prominent hot spring (*vern.* 'tata' – hot; 'pani' – water) emanating from the southern boundary fault near Tatapani Village. The coalfield lies between latitudes 23°30' : 23°55' and longitudes 83°00' : 83°40' and is located in the Surguja District of Chhattisgarh State, India.

C.L. Griesbach did the pioneering survey of the basin and mapped the different formations (Griesbach, 1880). Subsequently, detailed mapping of the area was carried out during the 1950s, 1960s and 1970s by the Coal Wing of the Geological Survey of India, though the remoteness of the region and lack of proper communication facilities were a major hindrance in the development of the coalfield (Raja Rao, 1982). However, since the last two decades, the coalfield has been taken up as one of the major thrust areas for the exploration of coal reserves and the Coal Wing, G.S.I. has carried out detailed mapping in different blocks of the coalfield (Bandopadhyay & Shome, 1991; Nag & Ray, 1991; Das & Shome, 1992; Barua *et al.*, 1992; Das *et al.*, 1997). Prognostication of the sub-surface coal seams have been undertaken through intensive drilling and recently, the coalfield has been opened for mining operations. Palaeobotanical studies in the area were initiated in the 1970s by the Birbal Sahni Institute of Palaeobotany (Bose *et al.*, 1977). Thereafter, in the 1990s, detailed palynological studies were undertaken in a major way,

| AGE | FORMATION | LITHOLOGY |
|----------------|------------------|---|
| Recent | | Alluvium |
| Cretaceous? | Basic intrusives | Dolerite dykes. |
| Upper Triassic | Mahadeva | Thick, cross-bedded, coarse-grained, ferruginous sandstone. |
| Lower Triassic | Panchet | Yellowish, fine-grained sandstone with alternating red and green siltstones, shales and clays. |
| Upper Permian | Raniganj | Micaceous, fine-grained, ripple laminated sandstones, grey and carbonaceous shales and shaly coal bands. |
| Middle Permian | Barren Measures | Ironstone shales showing box structure, fine-grained sandstone, shales and argillaceous sandstone. |
| Lower Permian | Barakar | Medium- to coarse-grained pebbly arkosic sandstone, grey and carbonaceous shales and coal seams. |
| | Karharbari | Coarse-grained to granular arkosic sandstone with conglomerate lenses, shales, carbonaceous shales and intermittent coal seams. |
| | Talchir | Diamictite, khaki-green needle shales, siltstone, fine-grained sandstone and varves. |
| Unconformity | | |
| Archaean | | Granites, gneisses, micaceous green schists, phyllites and quartz veins. |

Fig. 1—Generalised Stratigraphic Sequence of Tatapani-Ramkola Coalfield (modified after Raja Rao, 1982).

especially pertaining to the demarcation of inter-formational boundaries, palynological dating, coal seam correlation and delimitation of coal bearing horizons (Srivastava *et al.*, 1997; Srivastava & Kar, 2001; Kar, 1998, 2001, 2003; Kar & Srivastava, 2003). Coal petrological investigations and megafossil studies have also been undertaken from the area (Sarana, 2002; Sarana & Anand-Prakash, 2002; Chandra *et al.*, 2008; Sarana & Kar, 2011; Singh *et al.*, 2011).

GEOLOGICAL SETTING

The Gondwana Sequence in the Tatapani-Ramkola Coalfield is constituted by the sediments of Talchir, Karharbari, Barakar, Barren Measures, Raniganj, Panchet and Mahadeva formations (Fig. 1). Sediments of the Karharbari and Barren Measures formations were initially not recorded and these were subsequently established by palynological work (Kar & Srivastava, 2003; Kar, 2003). The coalfield is represented mostly by a plain area with minor undulations; the central part is occupied by a wide expanse of supra Panchet sediments forming ridges and low hills. The Gondwana sediments are cut off by the Great Boundary Fault and are flanked by hillocks of Precambrian basement rocks. The Talchir Formation forms the basal part of the Gondwana Sequence. Though restricted in outcrops, this formation is present throughout the coalfield, mostly along the north and northeastern margin of the Tatapani Basin.

Uro Nala Section—An excellent section of Talchir Formation is exposed along a stream cutting (Uro Nala) in the northeastern part of the coalfield (Fig. 2). The initiation of Gondwana sedimentation in the basin is manifested in the form of glacial boulder bed having its contact with the basement crystalline schists. The contact between the basement crystalline schists and Talchir boulder bed can be observed just below the road bridge in Uro Nala (Pl. 1.1). The boulder bed is characterised by the presence of unsorted boulders and is comparable to a lithified till. The angularity of the clasts is clearly seen and they range in size from a few centimeters to 50 cm (Pl. 1.2). Above the boulder bed, khaki-green shale beds are exposed, which weather into characteristic needle-shales, typical of the Talchir Formation (Pl. 1.3). This is followed by silty shales and sandstones, interbedding a thin band of varve clays. A second glacial boulder bed is further exposed characterised by poorly sorted boulders of different shapes and sizes. Above the second boulder bed, another bed of needle-shales having a number of rafted boulders and a layer of varve clays is exposed (Pl. 1.4).

The glaciogenic nature of the Talchir Formation is manifested by the presence of lithified tillite having unsorted, angular clasts that are typical of glacial origin. Thereafter, the amelioration of climate and melting of ice might have resulted in the deposition of fluvial and lacustrine sediments; whereby shales and sandstones were deposited. The presence of the

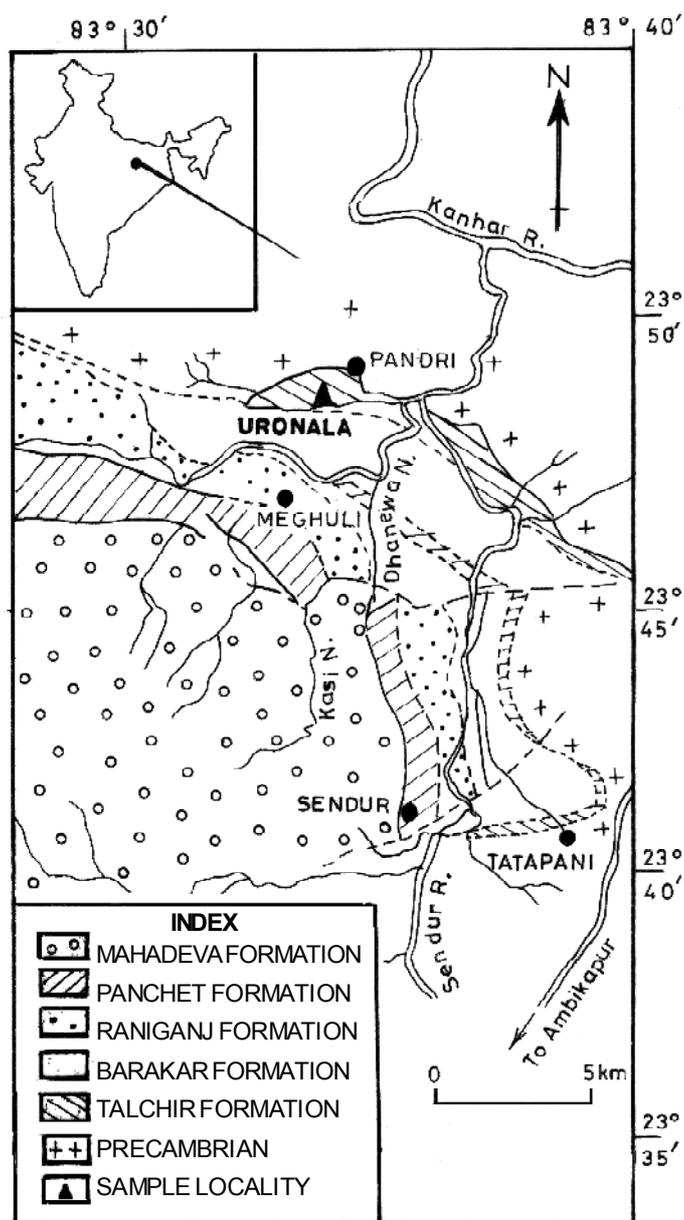


Fig. 2—Geological map of the northeastern part of Tatapani-Ramkola Coalfield showing the sampling locality.

second boulder bed and the rafted boulders imbedded in the overlying shale horizon, point towards the recurrence of glacial conditions in the area. The section in Uro Nala has also been measured and the thickness of Talchir Formation exposed in the stream cutting is about 50 m (Fig. 3).

MATERIAL AND METHODS

Nine samples were collected from different lithological units across the section starting from the basal boulder bed upwards up to the confluence of the Uro Nala with the Sendur River (Fig. 2). For the release of palynomorphs, about 20 gms

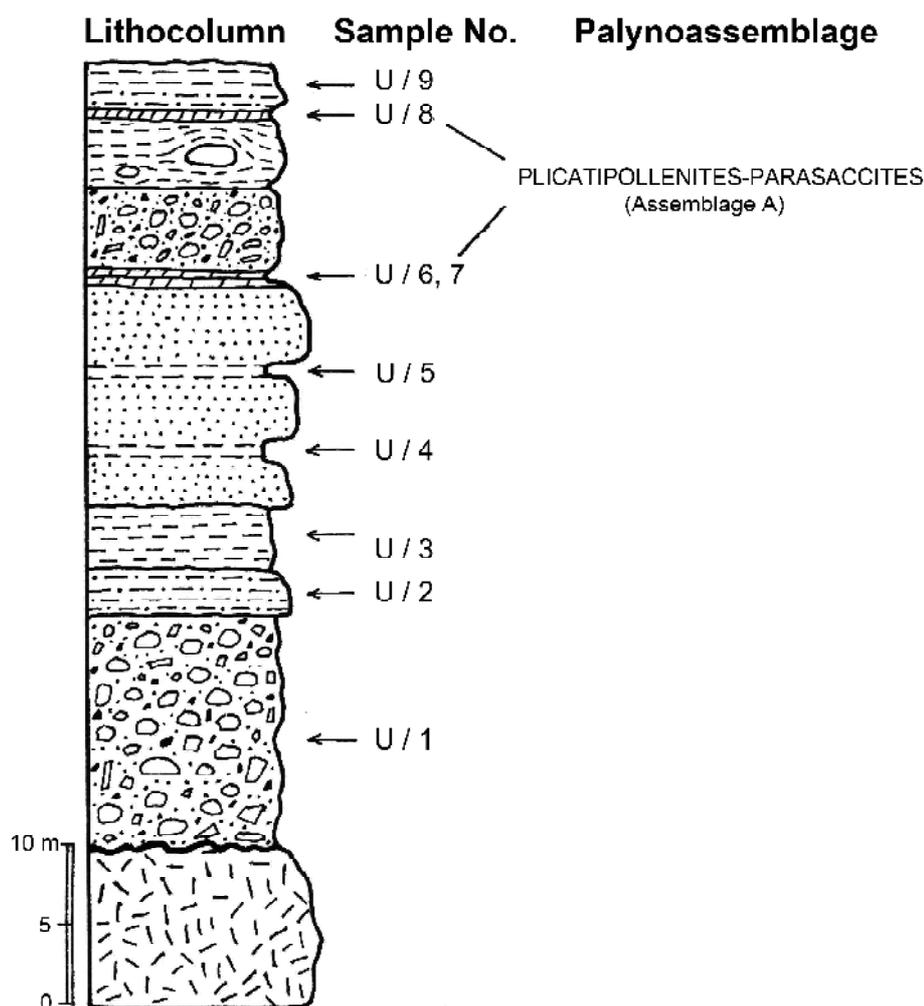


Fig. 3—Lithological section of the Talchir Formation exposed at Uro Nala showing the different lithounits and position of samples.

of each sample were crushed to 2-4 mm size and subjected to acid treatment (maceration) in well-labelled plastic jars. The samples were first treated with Hydrochloric acid for 2-3 days to get rid of the carbonates, if any. Thereafter, the samples were thoroughly washed and treated with 40% Hydrofluoric acid to remove the silica. Since all the samples were quite rich in silica, they required sustained Hydrofluoric acid treatment for two to three weeks to get rid of the silica content. After repeated reactions with Hydrofluoric acid, the pollen/spores were released from the sediments and further treatment with Nitric acid was not required as the sediments were devoid of carbonaceous debris. The residue of each sample was thoroughly washed and palynomorphs were taken from the 400 mesh size sieve. Since the yield of palynomorphs was poor, 100 miospores were counted at the generic level to calculate the percentage frequency of various genera in each sample for quantitative analysis.

PALYNOLOGICAL ASSEMBLAGE

Only the two samples of varve clays (U/6, U/8) have yielded palynofossils, while other samples from the section have proved to be barren (Fig. 3). The assemblage, though well preserved, appears to be less diversified and is dominated by *Plicatipollenites* (26-31%) with a sub-dominance of *Parasaccites* (8-22%). *Potonieisporites*, *Virkipollenites*, *Caheniasaccites* and *Sahnites* are the other important constituents. *Divarisaccus* is present only in the lower sample (5%). Triletes are present in the lower part of the section with *Callumispora* (6%) and *Jayantisporites* (2%) being the only representative forms. Striate disaccetes are rare and only few grains of *Faunipollenites*, *Striatites*, *Striatopodocarpites* and *Crescentipollenites* are observed. *Gingkocycadophytus* (2-3%) is common while *Botryococcus* (3%) is present only in the lower sample. There is abundance of *Leiosphaeridia* in the upper part of the section with percentage frequency as high as 43% (Fig. 4).

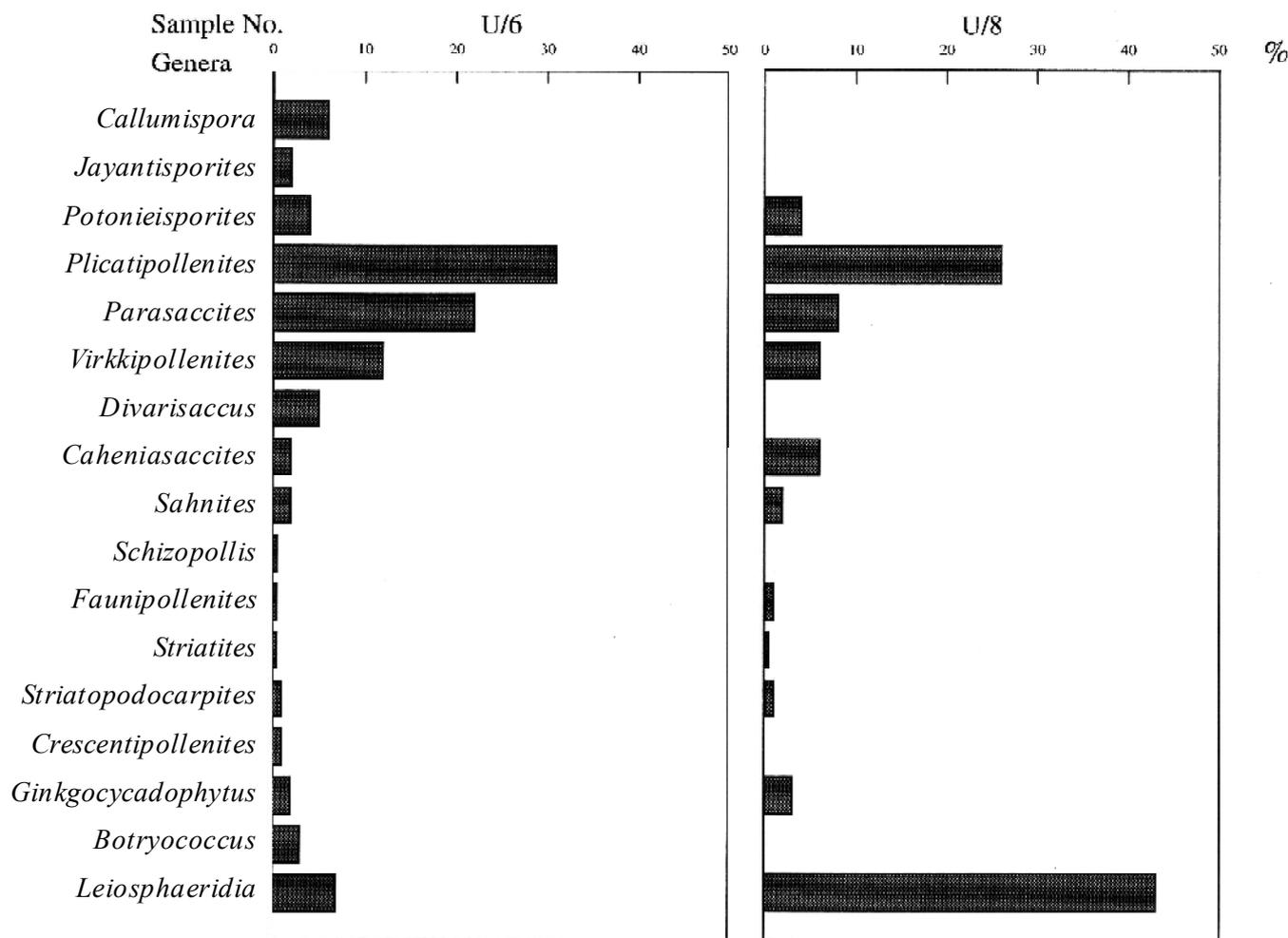


Fig. 4—Histogram showing quantitative distribution of taxa in Uro Nala section (Talchir Formation), Tatapani-Ramkola Coalfield.

The salient features of the assemblage are:

- Poor in overall diversity and is completely dominated by radial monosaccates.
- Acme zone of *Plicatipollenites gondwanensis*.
- Stratigraphically important taxa: *Callumispora*, *Potonieisorites*, *Virkipollenites*, *Divarisaccus*, *Caheniasaccites*, *Sahnites*.
- First Appearance Datum (FAD): *Callumispora*, *Jyantisorites*, *Virkipollenites*, *Caheniasaccites*, *Divarisaccus*, *Faunipollenites*, *Striatopodocarpites* and *Striatites*.
- Characteristic Palynoassemblage: *Plicatipollenites-Parasaccites*.

CORRELATION AND STRATIGRAPHIC POSITION

The assemblage is totally dominated by radial monosaccates (*Plicatipollenites* – dominant; *Parasaccites* – subdominant), while triletes and disaccates are poorly represented. Lele (1975) described two miofloral assemblages

– one from the base and another from the top of Talchir Formation, in the West Bokaro Coalfield. In the older horizon *Plicatipollenites* is dominant, while in the younger horizon *Parasaccites* is in dominance. Thus, the present assemblage is comparable to the older horizon of Talchir Formation. It is also closely comparable to the other known assemblages of Talchir Formation recovered from South Rewa Gondwana Basin at Goraia (Potonié & Lele, 1961); from Jayanti Coalfield (Lele & Karim, 1971; Lele & Makada, 1972) and from Mohpani Coalfield (Bharadwaj & Anand-Prakash, 1972). Lele & Chandra (1973) also described a Talchir Assemblage from Johilla Coalfield which is rich in *Rugasaccites* along with *Plicatipollenites* and *Parasaccites*. The present palynozone also shows a close resemblance to the above mentioned assemblage except, that here genus *Rugasaccites* is absent. The mioflora described from the marine intercalations near Manendragarh (Lele & Chandra, 1969, 1972) and Palynozone-1 of Bharadwaj *et al.* (1979) also from Manendragarh, are comparable to the present assemblage. A *Plicatipollenites-Parasaccites* assemblage has further been recorded from the Chuberbhita Coalfield (Banerjee

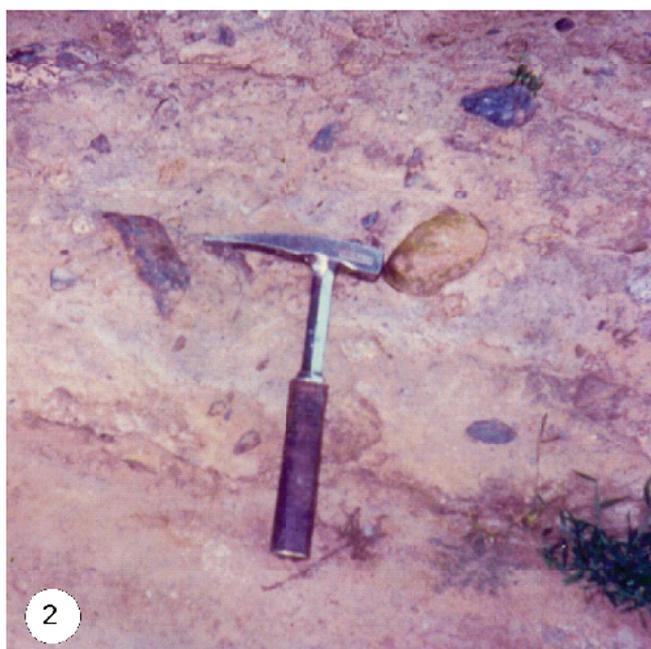
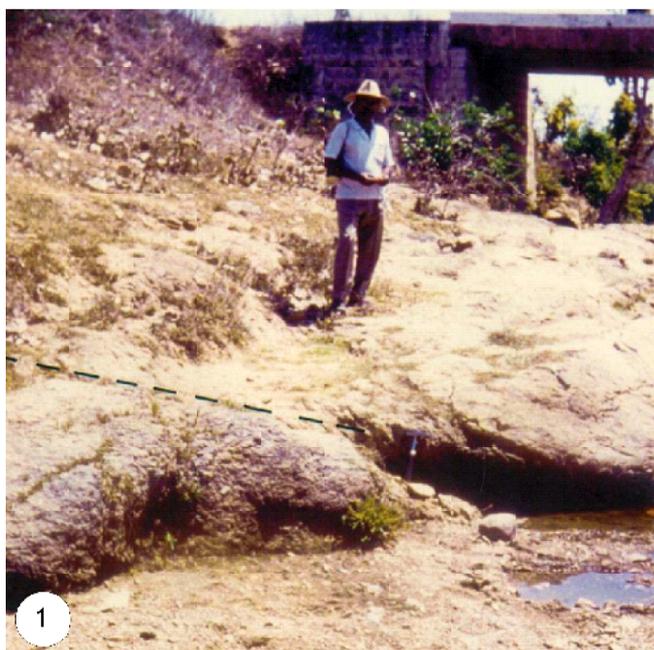


PLATE 1

1. Basement-Talchir contact (marked by line) exposed in Uro Nala. Basement rocks are represented by schists, while boulder bed is representative of Talchir Formation.
2. Close-up of boulder bed showing unsorted angular fragments of basement rocks in sandy matrix.
3. Khaki-green shales of Talchir Formation, showing typical needle like weathering exposed in Uro Nala.
4. Sequence of boulder bed, siltstone, varves and needle shales exposed in Uro Nala. A rafted boulder is also seen in the background.

& D'Rozario, 1988). A similar assemblage has been recovered from the Betul Coalfield in Satpura Basin (Srivastava *et al.*, 1989). From the Godavari Graben, a closely comparable palynoassemblage has been described from the Budharam area

(Palynozone-1, Srivastava & Jha, 1995). Thus, the palynoflora represents Lower Talchir Palynozone and is early Permian (Asselian) in age (Tiwari & Tripathi, 1992).

REMARKS

By virtue of having more than 99% of the coal reserves of India, the Gondwana sequences have received much attention in different geological aspects. A lot of palynological work has also been done as palynology has proved to be one of the best tools for delimitation of different formations, identification of coal bearing horizons, optimization of drilling operations for the estimation of coal reserves and sub-surface coal seam correlation. However, the Talchir Formation, since devoid of coal, has not received that much of importance and palynological data is comparatively much lesser as compared to the overlying coaliferous formations. Moreover, the paucity of palynomorphs was also a factor in discouraging workers from taking up such studies. Nonetheless, palynological studies of the Talchir Formation are of much importance to understand the evolution of flora at the initiation of Gondwana sedimentation, when the climate was still frigid and a glacial environment prevailed. As mentioned above, though lithostratigraphically the base of the Talchir Formation has been put at terminal Carboniferous (Gzhelian) as in other Gondwana continents, the lack of marker fossils, particularly palynofossil assemblages from the Indian deposits, has warranted its age to be early Permian. However, a pertinent question arises that have we searched and looked hard enough for deposits which may yield a flora older than the known early Permian assemblages. In this context, intensive palynological studies of the Talchir Formation, particularly from the basal part are required. Since India is endowed with extensive Gondwana sequences, which are well-mapped, a concerted effort in this direction will probably help to resolve one of the lacunas of Indian Gondwana geology.

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