

Palaeoclimatic significance of non - striate disaccate pollen in Yellandu coalfield of Godavari graben, Telangana State

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Abstract

The present palaeopalynological study deals with the significance of non - striate disaccate pollen from bore hole Q - 563 of Yellandu coalfield (Jawahar Khani - 5 coal block), Kothagudem sub-basin and to determine the age and palaeoclimatic interpretations of the study area based on the pollen morphological characters. For the palynological investigation, sixty samples were thoroughly analyzed in which fairly diversified palynofloral assemblages of Gondwanic affinity were recorded. About 30 genera and 50 species of palynomorphs, belong to Glossopteridales, Coniferales, Cordaitales of gymnospermous pollen, pteridophytic spores. In the present communication, the palynoflora belongs to Glossopteridales viz. *Scheuringipollentites barakarensis*, *S. maximus*, *S. tentulus*, *Ibisporites diplosaccus*, *Primuspollenites levis*, *P. densus* and *Sahnites thomasii* etc. Frequency distribution pattern of the palynotaxa reveals that the assemblage is dominated by the non - striate disaccates followed by striate disaccates, monosaccates (gymnosperms) and pteridophytic spores.

The diversified palynoassemblage of both non striate and striate disaccates pollen strongly signifies that the Yellandu coal belt of Godavari graben belongs to Barakar Formation of Early Permian age (Late Sakmarian – Early Artinskian). Predominance of non - striate disaccate pollen recorded from the Yellandu sediments indicates a warm and high humid climatic condition with fluvial environment of deposition.

Keywords: Non - striate disaccate pollen, Palaeoclimate, Barakar Formation, Early Permian, Yellandu Coal field, Godavari graben and Telangana State.

Introduction

Palaeopalynology is a branch of palaeobotany which deals with the study of microfossils (spores, pollen and acritarchs) from the geological past. This branch is used for biostratigraphy, palaeoecology, climate change and palynotaxonomy based on the microfossils. Palynology has become an important parameter in prospecting and economic utilization of fossil fuel exploration. Palynomorphs are recovered from the rock samples by the maceration technique and are identified on the basis of their

morphological characters. Well identified palynomorphs are good indicators of narrow time ranges and are also helpful in the discovery of oil, coal and gas deposits. As fossil spores and pollen are present in coal and associated sediments, these can be utilized for dating and stratigraphic correlation of coal-bearing horizons. Plant microfossils recovered from sediments most commonly represent the parent vegetation which was growing during the deposition of sediments.

Thus, the pollen and spores in the rocks of different times are quite different in their morphological and numerical characters as a result of which the presence of particular types of pollen and spores or palynoassemblages characterizes that particular horizon. Fossil spores and pollens exhibit various morphographic characters (thin/dense central body, radial monosaccate, haploxyloloid, non - striate bi saccus, non leathery saccus, diploxyloloid pollen with striation, taeniae and tetrad spores) each with a precise function.

Morphological features of fossil plants indicate a certain set of characters which are associated with a climatic regime. The micro fossils in lower Gondwana sequence also support the view of palaeoclimatic changes during Permian time which have control over the coal composition.⁴² The Glossopteridophyta group of plants were the organic matter source for the formation of lower Gondwana coal seams. Dating of coal and associated sediments is performed by the quantitative and qualitative analysis of these pollen and spores and correlation has been done by comparing the palynoflora of the area with the other rock strata.

So, the present palynological study is aimed to provide information regarding the record of non – striate disaccate pollen grains from sub-surface sediments of bore hole Q-563 of Yellandu coalfield area (Jawahar Khani-5 coal block), kothagudem sub-basin (Figure 1) to determine the age and palaeoclimatic interpretations based on the palynoassemblage and their morphological characters.

Geology of Study area

Indian Gondwana succession mostly exists as outliers lay down within the depression of the Pre-Cambrian basement. Indian Gondwana basins occur in the form of linear belt along with the present day river systems viz. Damodar Basin, Wardha-Godavari Basin, Son-Mahanadi Basin and Pech-Kanhan Tawa Valley coalfields etc. The Godavari Basin is further divided into four sub-basins viz. from NW–SE Godavari sub-basin, Kothagudem sub-basin,

Chintalapudi sub-basin and Krishna–Godavari coastal tract (figure 1). The Gondwana deposition in Godavari valley commenced with the glacial advancement as evidenced by the existence of structure less tillites and varves having droplets. However, deglaciation resulted in transformation of the valley into proglacial lakes, which provided suitable platform for the Gondwana deposition. Structurally, Godavari valley represents a rift valley having a NNW-SSE trend and covers 17,000 sq km area between 16°38' and 19°32' latitudes and 79°12' and 81°39' longitudes.

The Singareni coal fields of Godavari valley are one of the largest coal deposits of India in which the Yellandu area is one of the coal belts of Kothagudem sub-basin under Pranhita-Godavari basin. Yellandu coalfield is an elongate NNW-SSE trending basin, 20 km long and 6 km wide, parallel to the trend of Pranhita-godavari basin to the east. It is a graben bound by faults along the eastern and western margins. Yellandu coal field area (Jawahar Khani-5 coal block) is situated about 40 km west of Kothagudem, outside the western margin of Pranhita-Godavari basin. The

Yellandu coal belt is bound by northern latitude 17°29' 55" to 17°33' 59" and eastern longitude 80°19' 04" to 80°32' 45" and falls in Survey of India toposheet no 65C/6/SW. This coal belt/basin covers a large tract of about 2500 sq.km overlying on the Archaean gneisses, granite and schists of Gondwana sequence.

The Gondwana sediments of the Yellandu coal field area overlie the Archaean - proterozoic basement of Pakhal formation unconformably. They include lower to upper Permian of Talchir, Barakar, Barren Measures and upper Permian to lower Triassic Kamthi Formations (table 2). The entire coal block is covered by Barakar formation. This formation contains 6 coal seams namely E/King Seam, seam D, seam C, seam B, A/Queen seam and index seam in descending order (table 1). The pioneering geological work has been done by King (1872, 1872a, 1873, 1877, 1881) Blanford (1871, 1871a). Some important contributions on palynology of Godavari basin were done by many researchers.^{1-3,10-14,22,24,26,28-31,33-37}

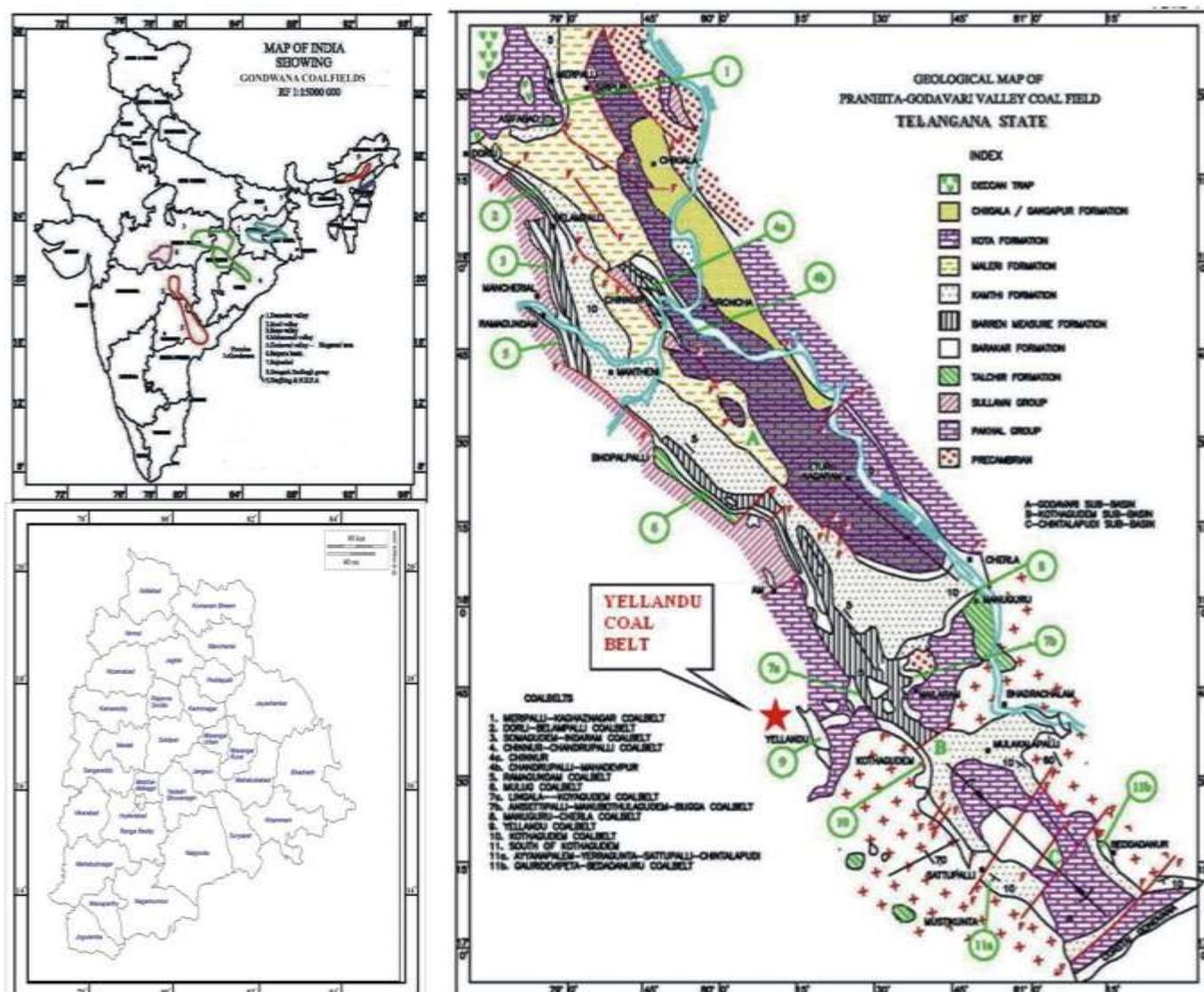


Figure 1: Gondwana basins of India along with Pranhita - Godavari Valley coal field of Telangana State.

Table 1

Lithological succession in B. H. Q - 563, Jawahar Khani - 5 coal block, Yellandu coalfield area, Kothagudem Basin.

Coal seam	Thickness of coal seams with parting (m)	Formation
I seam	25-50	Kamthi Formation Barakar Formation " " " " " " " "
Index Seam	1.10-4.40	
A/Queen Seam	1.50-21.60	
B Seam	0.25-2.25	
C Seam	0.25-4.25	
D Seam	0.30-6.10	
E/King Seam	0.15-4.10	

Table 2

Lithological succession in Yellandu coalfield area, Kothagudem Basin, Godavari graben.

Group	Age	Formation	Lithology
L O W E R G O N D W A N A	Upper Permian to Lower Triassic	Kamthi	Fine to coarse grained greenish grey to grey with subordinate sandstone, argillaceous sandstone, shaly clay with few coal seams.
	Upper Permian	Barren Measures	Medium to coarse-grained, greenish grey to greyish white Measures felspathic sandstones with subordinate variegated and micaceous sandstones dominantly with Grey Clay devoid of any workable Coal Seam.
	Upper part of Lower Permian	Barakar	Medium to Coarse-grained, White felspathic sandstone, Siltstone, shale, carbonaceous shale and coal seams. Very coarse grained, pebbly felspathic sandstone.
	Lower Permian	Talchir	Fine-grained sandstones, splintery green clays/shales, Chocolate coloured clays, pebble beds and tillite.
	Upper Proterozoic	Sullavi	-----Unconformity ----- Medium to coarse-grained, white to brick red sandstones, at place quartzitic and mottled shales.
	Lower Proterozoic	Pakhal	-----Unconformity ----- Greyish white to buff quartzites, grey shales, phyllites and marble.
	Precambrian	-	-----Unconformity ----- Granites, banded gneisses, biotite gneisses, hornblende gneisses, quartz magnetite schists, biotite schists, quartz and pegmatite veins.

Material and Methods

For the present study, coal samples have been collected from Jawahar Khani-5 coal block near Yellandu village. A total of 60 bore core samples were collected from the Bore Hole no: Queen Seam – 563 for palynological investigation. Bore-cores are the ideal material for palynological analysis as these provide samples which are fresh and contamination free. The lithology of samples viz. coal, shaly coal, carbonaceous shale, dark grey shales and sand stones is presented in figure 2.

The total depth of the borehole was 441.00m but samples were collected from the Index seam and A/Queen seam from the depths of 289 m to 314 m for qualitative and quantitative analysis of palynomorphs. Each coal sample represents about 1-2 meter vertical length of the Queen seam, except at places where thick coal bands were not available.

The samples were processed by standard palynological method (Traverse. A, 1988) using acids like hydrochloric acid (HCL) for 1-2 days, then cleaned and filtered with distilled water for 3-4 times and after that, treated with

hydrofluoric acid (HF) for 3–4 days (to dissolve the silicates), then again filtered with distilled water followed by concentrated nitric acid (HNO₃) for 2–5 days and then finally with 10% alkali (KOH) treatment. The materials were sieved through 150 and 400 meshes and palynological slides were prepared using DPX as mounting medium for the recovery of palynomorphs from the coal samples.

For the palynological investigation, 5 slides were prepared for each sample. Microscopic observation has been made on Olympus microscope with 10 mega pixels Nikon digital camera. The prepared slides were kept and stored in the Palaeobotany and Palynology Research Laboratory, Department of Botany, University College of Science, Saifabad, Hyderabad.

Results

Sixty samples were analyzed from the Jawahar khani - 5 for the palynological investigation, well preserved and fairly diversified palynofloral assemblages of Gondwanic affinity recorded from the coal sediments. About 30 genera and 46 species of palynomorphs belonging to Glossopteridales,

Coniferales, Cordaitales of gymnospermous pollen besides pteridophytic spores, few acritarchs and thecamoebians were recorded. The detailed quantitative analysis and

palynofloral frequencies of sixty bore core samples (Q - 563) were given in figure 3.

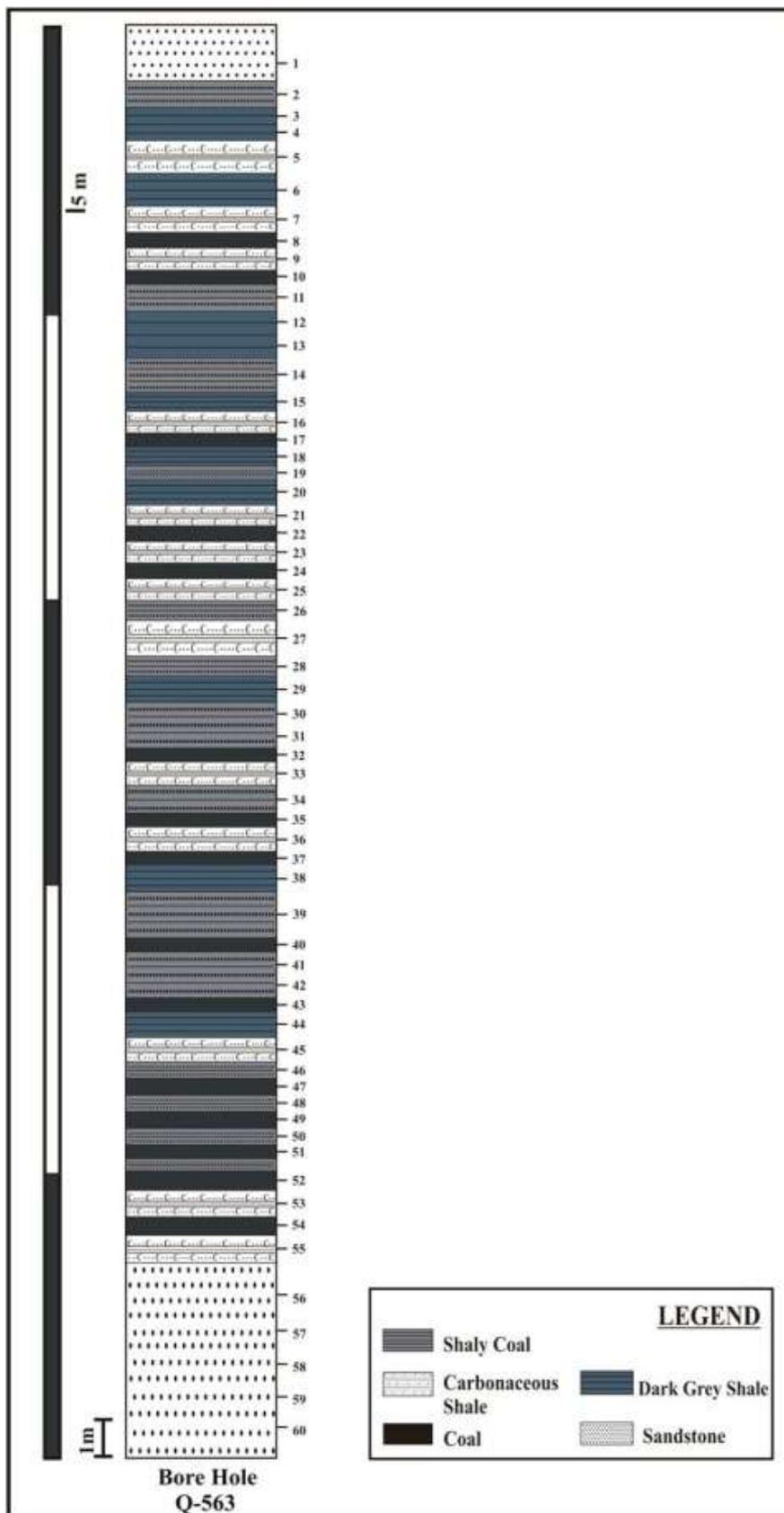


Figure 2: Lithology of B. H. No. Q - 563, Jawahar Khani – 5, Yellandu area, Kothagudem sub-basin, Godavari valley coalfield, Telangana State.

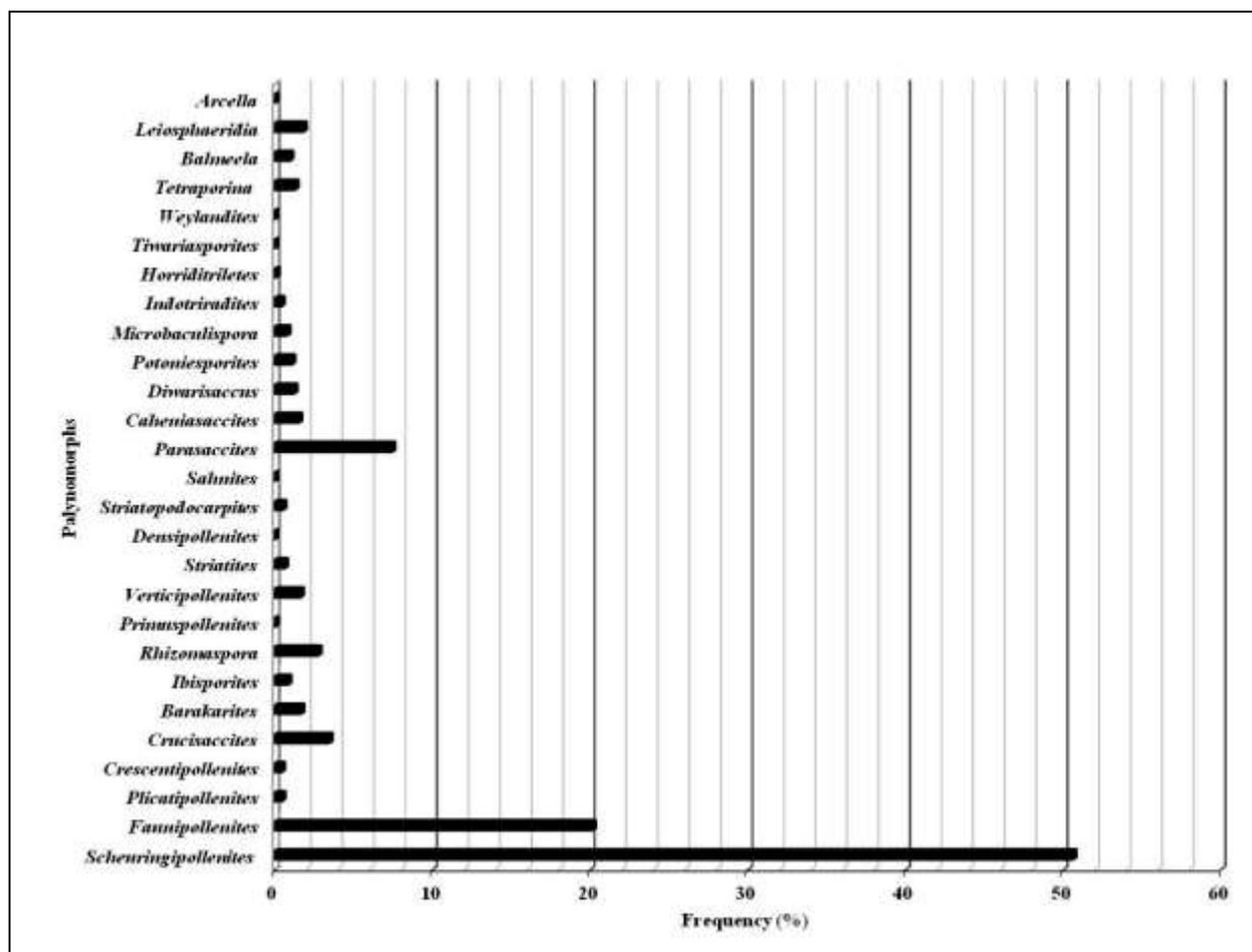


Figure 3: Histogram showing the palynofloral frequency of Q – 563 samples from Jawahar khani - 5 coal block of Yellandu coalfield.

In the present communication, the palynoflora belonging to Glossopteridales viz. *Scheuringipollenites barakarensis*, *S. maximus*, *S. tentulus*, *Ibisporites diplosaccus*, *Primuspollenites levis*, *P. densus* and *Sahnites thomasii* were given (plate 1) in a systematic way based on the Bharadwaj classification system.^{2,3}

Palynological analysis:

1. Genus - *Scheuringipollenites* (Leschik) Bharadwaj¹ Type species - *Scheuringipollenites interpositus* Leschik²¹

Scheuringipollenites barakarensis Tiwari⁴⁰ Holotype-Tiwari;⁴⁰ PI. 1, Fig. 2.

Plate - 1, figure 3

Description: Pollen grains disaccate bilaterally symmetrical, haploxylooid in nature, non – striate, 107 µm x 115 µm in size. Central body thin, outline indistinct, non – striate. Sacci less than semi – circular in shape, finely reticulate exine. Narrow sulcus formed between saccus bases, sacci intrareticulate.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

2. *Scheuringipollenites maximus* (Hart) Tiwari⁴⁰ Holotype - (Hart) Tiwari;⁴⁰ PI. 2, Fig. 6.

Plate - 1, figure 2

Description: Pollen grains disaccate bilaterally symmetrical, haploxylooid in nature, quadrangular in shape, non – striate, 82 µm x 103 µm in size. Central body thin, indistinct, non – striate. Saccus free area narrow, sacci are folded at Saccus free area, sacci intrareticulate.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

3. *Scheuringipollenites tentulus* Tiwari³⁹ Holotype – Tiwari;³⁹ PI. 7, Fig. 81.

Plate - 1, figure 1

Description: Pollen grains disaccate bilaterally symmetrical, haploxylooid in nature, circular to sub-circular in shape, non – striate, 82 µm x 103 µm in size. Central body thin, indistinct, non – striated. Saccus free area prominent, wide, distal sacci zone close to the centre but widening apart laterally, sacci intrareticulation medium.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

4. Genus - *Ibisporites* Tiwari³⁹

Type species - *Ibisporites diplosaccus* Tiwari³⁹

Ibisporites diplosaccus Tiwari³⁹

Holotype - Tiwari;³⁹ P1.67 Fig.67-74.

Plate - 1, figure 7 - 9

Description: Pollen grains disaccate bilaterally symmetrical, 76 µm x 108 µm in size diploxylonoid in nature, Central body indistinct, thin, vertically oval in shape, sulcus narrow, sub-circular with lateral notch, sacchi sub-circular, sacchi intrareticulation mediumly coarse, exine fine to medially reticulate.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

5. Genus - *Primuspollenites* Tiwari⁴¹

Type species - *Primuspollenites levis* Tiwari⁴¹

Primuspollenites levis Tiwari⁴¹

Holotype - Tiwari;⁴¹ PL. 1, Fig. 9.

Plate - 1, figure 4

Description: Pollen grains disaccate bilaterally symmetrical, 48 µm x 70 µm in size. Central body vertically oval and thin walled, having proximally nearly polygonal areas, bound by narrow grooves, resulting into a reticuloid pattern of striations. Sacchi encroaching the body with diffused zone of attachment, distally inclined and forming a definite sulcus. Sacchi continuous, laterally with distinct lateral notches, hemispherical and intrareticulate.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

6. *Primuspollenites densus* Tiwari.⁴¹

Holotype - Tiwari,⁴¹ PL. 5 Fig. 108.

Plate - 1, figure 5

Description: Pollen grains disaccate bilaterally symmetrical, diploxylonoid, 86 µm x 104 µm in size. Central body distinct, dense, vertically oval in shape, measuring 42 µm x 56 µm, reticuloid pattern of strations. Sacchi attachment difused, distal attachment being well defined. Sacchi sub hemispherical with finely intrareticulation.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

7. Genus: *Sahnites* Pant emend. Pant²³

Sahnites thomasii Pant 1955

Holotype - Pant,²³ PL. 19 Fig.1.

Plate - 1, figure 6

Description: Disaccate pollen grain, without striations, bilaterally symmetrical, central body microintrareticulate, mono, bi or trilete mark. Sacchi proximally equatorially attached, with the body, on the lateral sides generally with continuations and distally inclined, leaving a distinct saccus free area. Sacchi intrareticulate, protosaccate.

Locality: Borehole Q-563, Jawahar Khani-5 coal block, Yellandu coalfields, Telangana State, India.

Horizon and age: Barakar Formation - Early Permian.

Discussion

During the lower Gondwana sedimentation, the Gondwana basins of India witnessed different weather conditions because of its angular distance position, continentality and relief. Throughout Permian, the palaeolatitudinal position of India was between 20° and 45° S.³² As in alternative basins of the Gondwanaland, even in India initial sedimentation took place because of melting of glaciers. The Gondwana land throughout Permian period occupied in and round the sub - arctic region, once cold temperate weather conditions prevailed¹⁵ with alternating dry and rainy seasons.¹⁹

These weather conditions were appropriate for the luxuriant growth of Glossopteris flora⁷ in various Gondwana basins of India. The Yellandu coal field is slowly sinking faulted block^{4,38} of Godavari valley field wherever thick piles of the organic matter wealthy sediments were accumulated and later through time re-worked into the coal deposits.

Fox^{8,9} opined that the Gondwana coals have allochthonous origin, that contains higher frequency of organic matter content. Coal is formed both under hot humid tropical climate moreover as in cold and temperate regions.²⁰

Thus precipitation is the main requirement for the formation of coal, wherever the rainfall exceeds evaporation. Evidently, the flora contributed to the coal formation lived in an exceedingly damp climate, however not essentially within the hot tropical climate.

Morphological characters of microfossils indicate a particular set of characters which are related to an environmental condition regime. The microfossils in lower Gondwana sequence additionally support the view of palaeoclimatic changes throughout Permian time that have control over the coal composition.⁴²

Tiwari and Tripathi⁴² have more stressed the role of moisture and temperature and their interaction as a reason for morphological trends in numerous palynomorphs populations throughout the Permian period.

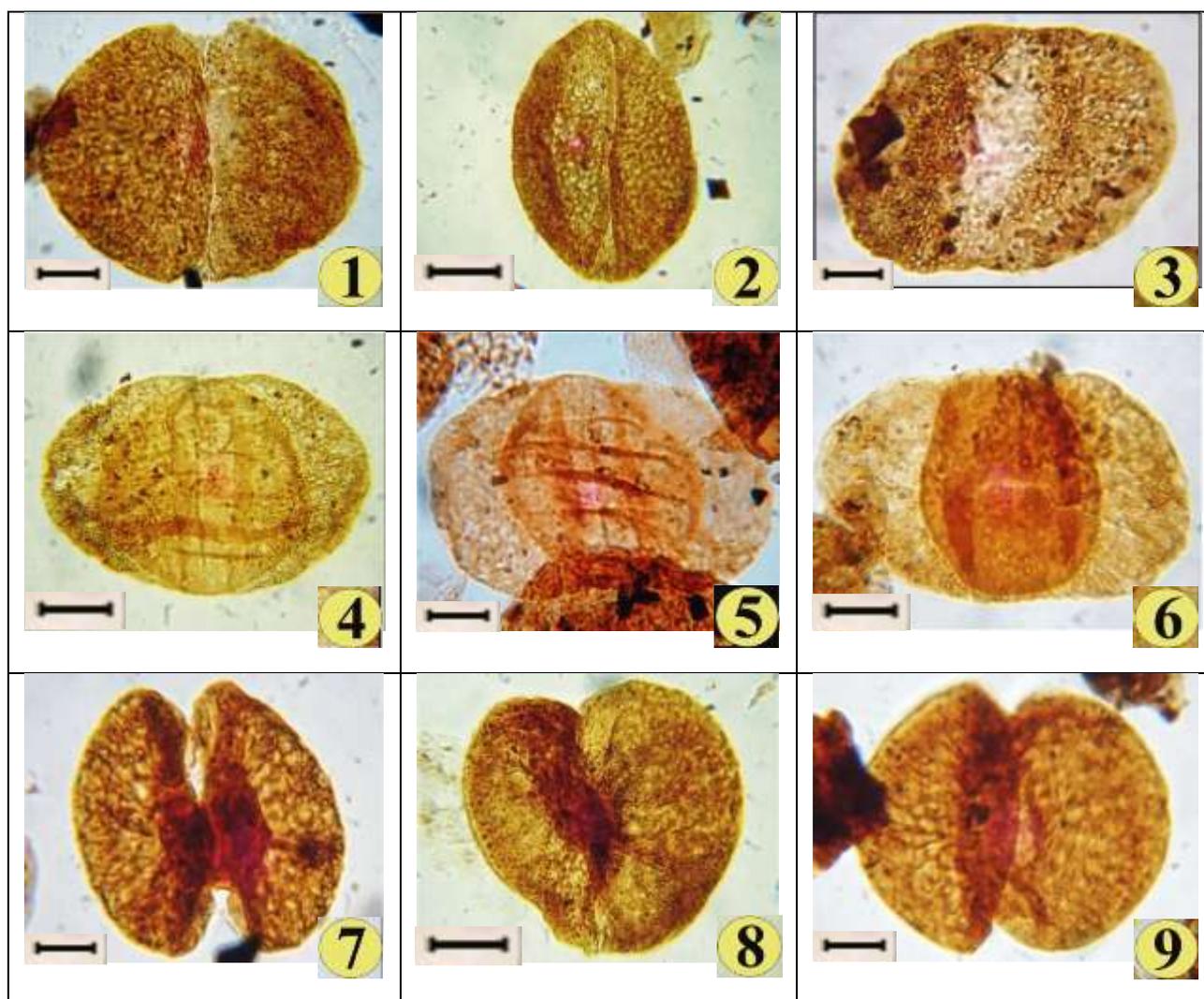


Plate 1: Non – striate disaccate palynoflora recorded from B. H. No. Q - 563, JK – 5 block, Yellandu coal field of Kothagudem sub-basin, Godavari valley coalfield, Telangana State; 1. *Scheuringipollenites tentulus* Tiwari 1968, 2. *S. maximus*, 3. *S. barakarensis* Tiwari 1973b, 4. *Primuspollenites levis* Tiwari 1964, 5. *P. densus* Tiwari 1964, 6. *Sahnites thomasii* Pant 1955, 7-9. *Ibisporites diplosaccus* Tiwari 1968

Therefore, in the present study, an endeavor has been created to assess various morphological features of spores and pollen reported from the JK-5 coal block of Yellandu field that were successively utilised for palaeoclimatic interpretations. The activity patterns of significant morphographic events were evaluated for their sensitivity to weather conditions.

Evaluation of morphographic characters of the palynomorphs reported from the JK-5 coal block of Yellandu field reveals a combination of thin/dense central body, radial monosaccate, haploxylooid, non leathered saccus conditions and diploxylooid pollen with striations that may be a combination of morphographic characters in suite – 5 and 6 (Composition – III of Tiwari and Tripathi⁴² suggesting that the Yellandu field witnessed cool to warm environmental conditions with high humidity conditions in early Permian period.

During the present palynological investigation, the palynoassemblages were present in Jawahar khani-5 which

incorporates extremely diversified palynomorphs like non striate disaccates followed by striate disaccates and monosaccates strongly suggesting the Barakar age for the sediments. The palynoassemblage is characterised by the predominance of nonstriate disaccate genus *Scheuringipollenites* and subdominance of striate disaccate genus *Faunipollenites* that typify the palynoassemblage belonging to Barakar Formation of Early Permian sediments. The age for the sequence at Q-563 is inferred as early permian (Late Sakmarian–Early Artinskian) age by comparison of the recorded flora from JK - 5 with other Gondwana palynofloras²⁸. The predominance of non - striate disaccate pollen indicates a warm and high humidity climatic conditions with fluvial environment of deposition of the Yellandu sediments.

Conclusion

Palynological data reveals an interesting point to note that the Jawahar Khani - 5 coal block of Yellandu coalfield of Godavari graben suggests very rich diverse assemblage

prevailing during the deposition of sediments. The diversified palynoassemblage is characterized by the dominance of non-striate disaccate genus *Scheuringipollenites* and sub dominance of striate disaccate genus *Faunipollenites* which typically indicate Early Permian sediments of Barakar formation.

Predominance of non - striate disaccate pollen indicates a warm and high humid climatic condition with fluvial environment of deposition of the Yellandu sediments. The age for the sequence at Q-563 is inferred as Early Permian (Late Sakmarian–Early Artinskian).

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