

Early and Late Permian palynofloras from the subsurface Lower Gondwana sediments near Brajrajnagar, Ib River Coalfield, Orissa

K. L. Meena, B. N. Jana and Neha Aggarwal

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow-226007, India
E-mail: klmeenascd@gmail.com; dipanjan_jana@rediffmail.com; neha_264840@yahoo.co.in

ABSTRACT

Meena K. L., Jana B. N. & Aggarwal N. 2011. Early and Late Permian palynofloras from the subsurface Lower Gondwana sediments near Brajrajnagar, Ib River Coalfield, Orissa. *Geophytology* 41(1-2): 83-90.

Palynological study of bore hole OIOC-74 reveals the presence of two distinct palynoassemblages recovered from the depth of 287-256m and 238-56.50m respectively. Palynoassemblage-I (287-256m) is characterized by the dominance of *Faunipollenites* and *Striatopodocarpites* along with non-striate disaccates *Scheuringipollenites* and *Ibisporites*. Palynoassemblage-II (238-56.50m) is differentiated by the dominance of *Striatopodocarpites* followed by *Faunipollenites*. The other palynotaxa, viz. *Scheuringipollenites*, *Ibisporites*, *Striapollenites*, *Crescentipollenites*, *Verticypollenites*, *Densipollenites magnicarpus*, *Parasaccites*, *Rhizomaspora*, *Microbaculispora*, *Inaperturopollenites*, etc. have also been recorded from Palynoassemblage-II along with the younger elements, viz. *Arcuatipollenites*, *Densoisporites* and *Lundbladispota*. The dominance of striate disaccates, viz. *Faunipollenites*, *Striatopodocarpites*, followed by non-striate disaccates in Palynoassemblage-I and absence of younger elements, viz. *Arcuatipollenites*, *Densoisporites* and *Lundbladispota* indicate Upper Barakar affinity. Hence, late Early Permian age has been assigned to this palynoflora. The overall composition of Palynoassemblage-II shows Raniganj affinity and Late Permian age has been assigned to this palynoflora.

Key-words: Palynology, Barakar, Raniganj, Brajrajnagar area, Jharsuguda, Ib River Coalfield, Son-Mahanadi Graben.

INTRODUCTION

The Ib River is located in the south-eastern part of NW-SE trending Mahanadi master basin belt between latitudes 21°30' and 24°14' N and longitudes 83° 32' and 84°10' E. It embraces the Hingir sub-basin in the north and the Rampur sub-basin in the south. The Ib River Gondwana belt is named after the Ib River (a tributary of Mahanadi) which covers parts of Sundargarh, Jharsuguda and Sambalpur districts of Orissa. The palynological investigations in Ib River Coalfield have been carried out by Tiwari (1968), Maiti (1994), Meena (1998, 1999a, 2000) and Meena and Goswami (2004).

GEOLOGY

The material for present study was collected from

B.H. OIOC-74, drilled near Brajrajnagar city, Jharsuguda District which is about 3 km away from the Gandhi Chouraha towards the Belpahar Railway Station.

Geologically, five major coal seams have been identified in the Ib River Coalfield, Orissa. Seam I-V have been named as Belpahar, Perkhani, Lajakura, Rampur (contact seam) and Ib coal seam respectively. Seam-V is the deepest seam in this coalfield. A complete geological succession of the area has been given in Table-1. The position of the drilled bore hole has been shown in Text-figure 1.

MATERIAL AND METHOD

Altogether, 41 samples of different lithologies, viz. grey shale, carbonaceous shale, coal and coaly shale, have been collected from drilled bore hole.

Table 1. Showing geological succession of Ib River Coalfield.

Age	Group	Formation	Lithology (Thickness in meters)
Recent		Alluvium/ Laterite	Recent gravel and conglomerate.
Early Middle Triassic	Middle Gondwana	Upper Kamthi	Conglomerate, red shale with <i>Dicroidium</i> flora (Pal et al. 1992) and coarse ferruginous sandstone with clasts (150m +)
----- Unconformity-----			
Late Permian	Lower Gondwana	Middle Kamthi (Raniganj)	Fine to medium grained well sorted sandstone, siltstone, clay bed, shale, coal (180m).
Middle Permian		Lower Kamthi=Barren Measures	Grey shale, carbonaceous shale, fine to coarse grained sandstone, clay and ironstone nodules/shale (250m +).
Early Permian		Barakar	Feldspathic sandstone, grey and carbonaceous shales, fire clay and thick coal seams (350-500m).
		Karharbari	Conglomerate, carbonaceous sandstone with fresh feldspar grains containing thin coal bands only along the NW margin of the basin. (30- 65m.).
		Talchir	Diamictite, greenish sandstone, olive coloured needle shales and rhythmities. (130m +).
----- Unconformity-----			
Precambrian			Granites, gneisses, amphibolites, migmatites

Palynomorphs from rock samples have been recovered by usual maceration technique which includes crushing (5-10gm/sample) followed by 2-4 days hydrofluoric acid treatment. After thorough washing with water post hydrofluoric acid organic residues were oxidized with nitric acid for 2-5 days followed by 10% KOH treatment. Samples were sieved with 150 and 400 mesh sieves. Permanent slides were prepared in canada balsam with the help of polyvinyl chloride (PVC). The scanning of these slides and the photography of the palynomorphs were done under Olympus BH-2 microscope. The collected samples and prepared palynological slides are housed at the museum of Birbal Sahni Institute of Palaeobotany, Lucknow. Depth and lithological details of studied samples have been given in Table-2 while litholog has been shown in Text-figure 2.

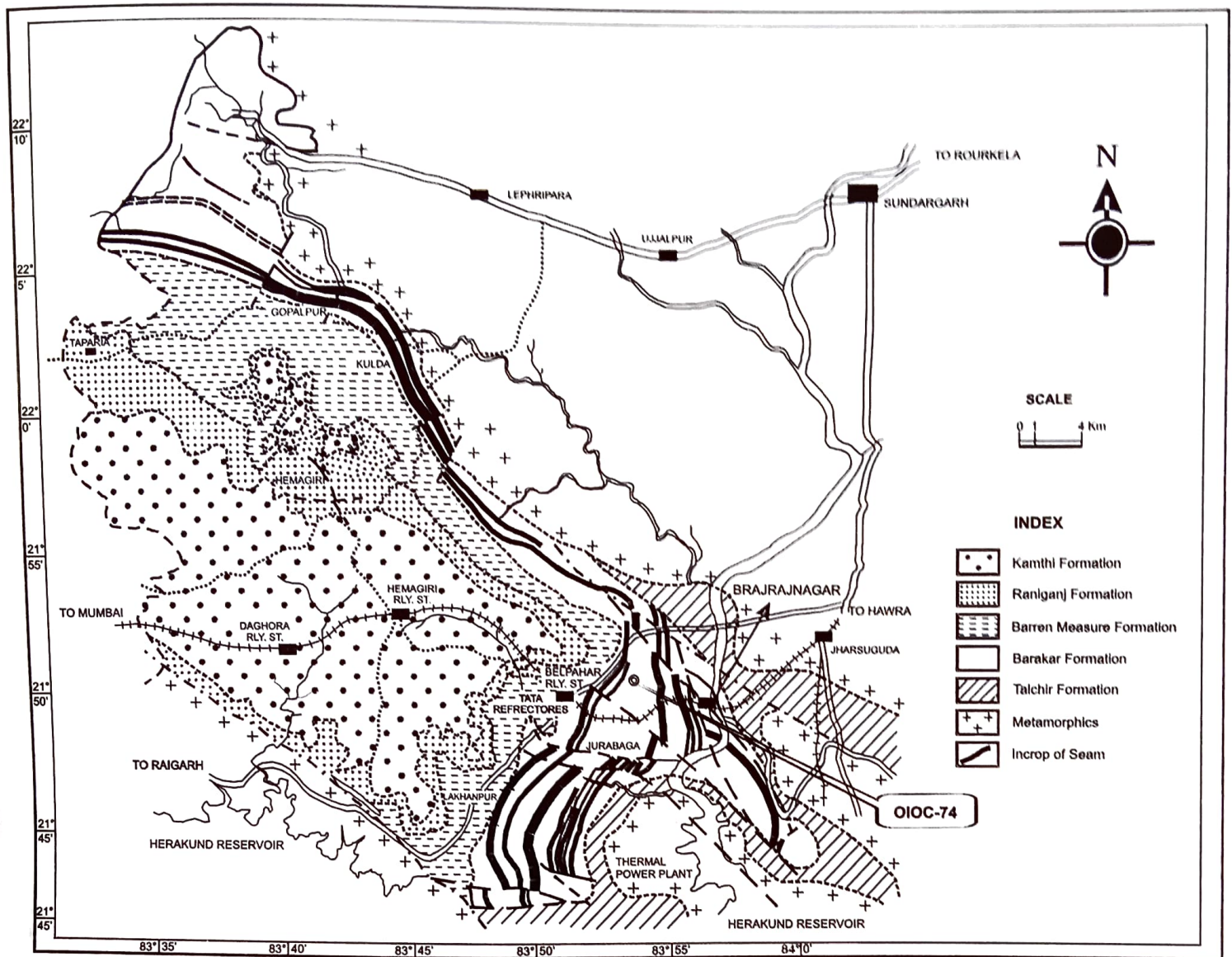
PALYNOLOGICAL ASSEMBLAGES

The palynological investigation of bore hole OIOC-74 has led to recognize two distinct palynoassemblages on the basis of their morphographic characters and numerical representation. The

percentage frequency and vertical distribution of various palynotaxa have been shown in Text-figure 3. Stratigraphically significant palynotaxa have been shown in Plate 1.

Palynoassemblage-I: Palynoassemblage-I, marked at the depth of 287-256 m, is characterized by the dominance of striate disaccates, viz. *Faunipollenites* (30-32%), *Striatopodocarpites* (10-19%) and the sub-dominance of nonstriate disaccate *Scheuringipollenites* (24-28%). Besides these, the other taxa recorded in this palynoassemblage are *Cyclogranisporites* (2%), *Microbaculispora* (1-2%), *Callumispora* (1-2%), *Densipollenites* (2-4%), *Parasaccites* (2-4%), *Ibisporites* (2%), *Distriatites* (1%), *Verticipollenites* (2-3%), *Crescentipollenites* (2-4%), *Guttulapollenites* (1-2%), *Weylandites* (2%), *Inaperturopollenites* (2%), *Rhizomaspora* (3%) and *Osmundacidites* (1%).

Palynoassemblage-II: Palynoassemblage-II, marked at the depth of 238-56.5 m, is distinguished by the dominance of striate disaccates, viz. *Striatopodocarpites* (24-30%), *Faunipollenites*



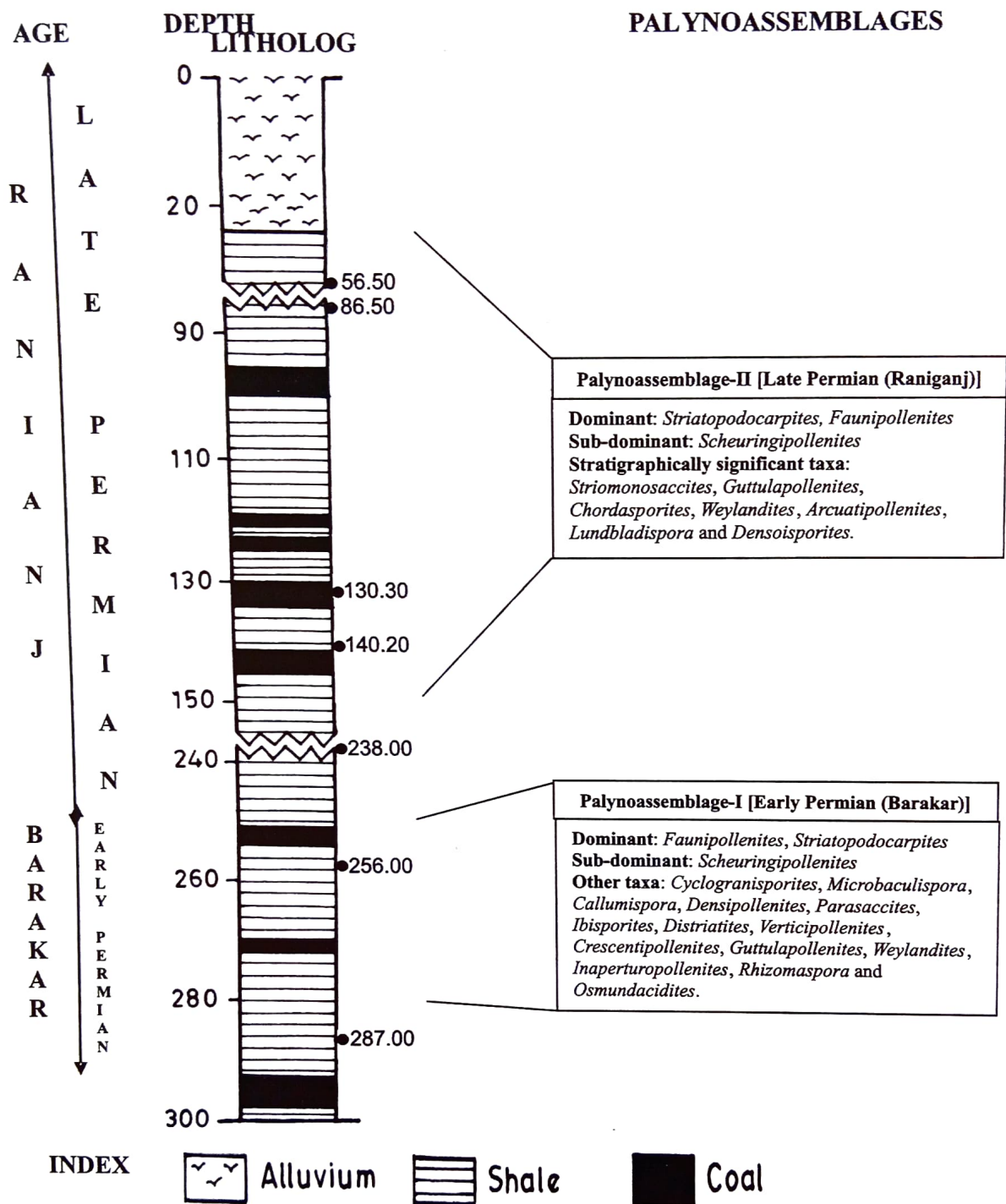
Text-figure 1. Map showing the location of B.H. OIOC-74, District Jharsuguda.

(18-24%) along with some stratigraphically significant taxa, viz. *Striomonosaccites* (2-4%), *Guttulapollenites* (1-3%), *Weylandites* (1-2%), *Arcuatipollenites* (4-6%), *Lundbladispora* (2-6%), *Chordasporites* (1-3%) and *Densoisporites* (2-4%). Besides these, other associated taxa of this palynoassemblage are *Ephedripites* (1-2%), *Cyclogranisporites* (1-2%), *Microbaculispora* (1-2%), *Callumispora* (1-2%), *Reticulatispora* (1%), *Densipollenites* (1-3%), *Parasaccites* (1%), *Ibisporites* (1-2%), *Scheuringipollenites* (4-8%), *Distriatites* (1%), *Distriamonosaccites* (1-3%), *Crescentipollenites* (3-5%), *Verticipollenites* (1-2%), *Striapollenites* (1-2%), *Strotersporites* (1%), *Corisaccites* (1%), *Inaperturopollenites* (1-3%),

Rhizomaspora (1-2%), *Navalesporites* (1-2%), *Acristarchs* (2-3%) and *Osmundacidites* (1%).

CORRELATION

Palynoassemblage-I compares well with Upper Barakar palynoflora of Chaturdhara Nala Section and Palynozone-1 of bore hole IBH-6, Ib river Coalfield (Meena 1999a, b); Zone-5 of Pusai-Shampur area, Raniganj Coalfield (Tiwari 1973); Zone-2 of Giridih Coalfield (Srivastava 1973); Zone-4 of Umaria Coalfield (Srivastava & Anand-Prakash 1984); Zone-4 of Johilla Coalfield (Anand-Prakash & Srivastava 1984); Assemblage-B of Barjora Coalfield (Kulshreshtha 1990); *Faunipollenites varius* assemblage zone (Tiwari & Tripathi 1992); Palynozone-



Text-figure 2. Litholog showing depths of location of palynoassemblages

Plate 1

1. *Lundbladispota microconata* Bharadwaj & Tiwari, Slide No. 14152, S58-2. 2. *Microbaculispora gondwanensis* Bharadwaj, Slide No. 14152, K56-1. 3. *Gondispota* sp., Slide No. 14153, V51-2. 4. *Reticulatispora* sp., Slide No. 14153, W35-1. 5. *Densipollenites magnicarpus* Tiwari & Rana, Slide No. 14153, G33. 6. *Chordasporites australiensis* de Jersey, Slide No. 14153, K39-4. 7. *Falcisporites stabilis* Balme, Slide No. 14152, M51-2. 8. *Striatopodocarpites* sp., Slide No. 14152, H60-4. 9. *Striatites communis* Bharadwaj & Salujha, Slide No. 14153, U64-4. 10. *Crescentipollenites globosus* (Maithy) Jha, Slide No. 14153, U45. 11. *Lunatisporites pellucidus* (Goubin) Maheshwari & Bnaerji, Slide No. 14152, Q41-3. 12. *Strotersporites indicus* Tiwari, Slide No. 14153, V42-1. 13. *Corisaccites distinctus* Venkatachala & Kar, Slide No. 14153, O37-3. 14. *Guttulapollenites hannonicus* Goubin, Slide No. 14153, U64-1. 15. *Weylandites obscures* (Tiwari) Bharadwaj & Dwivedi, Slide No. 14153, K57-3.

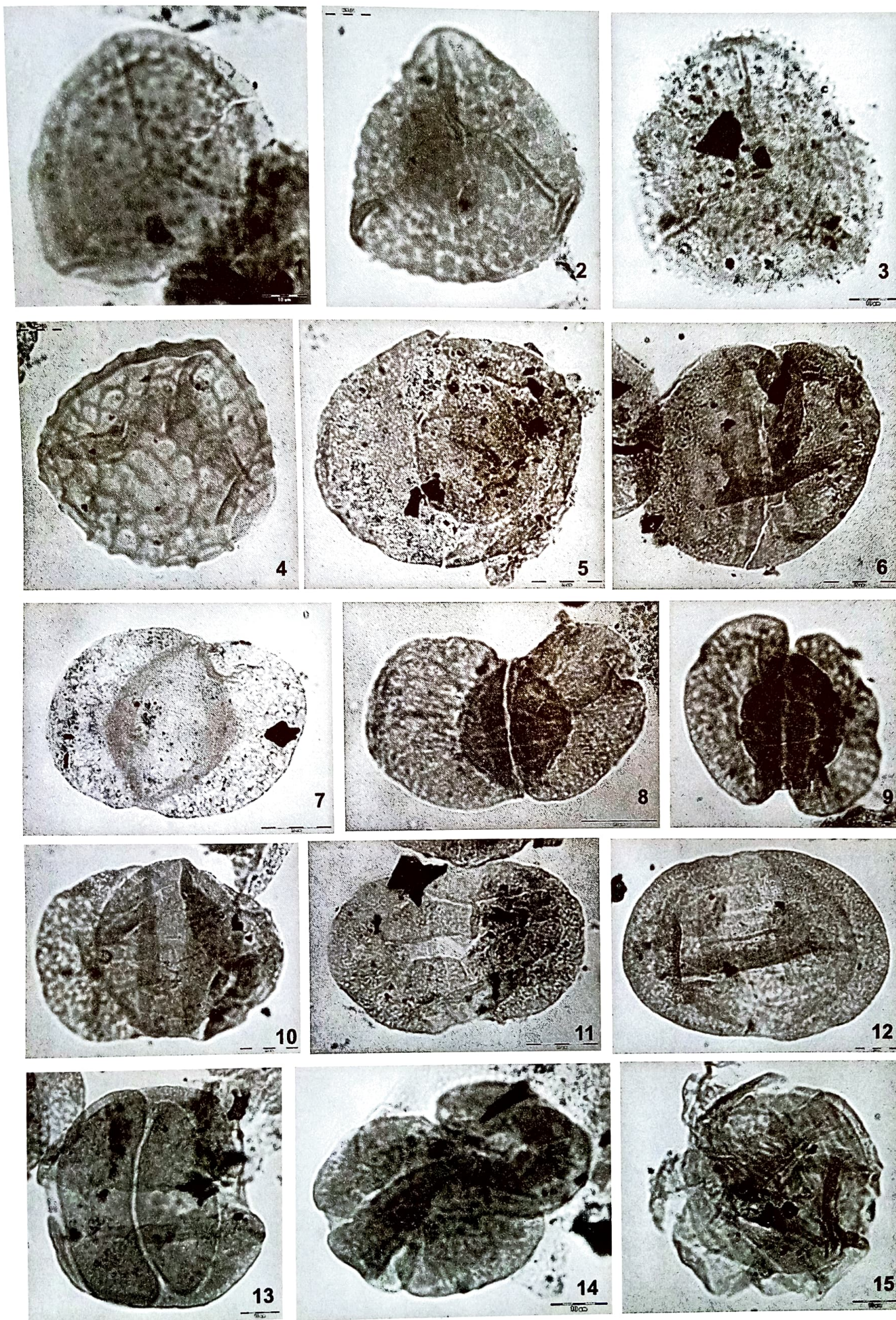
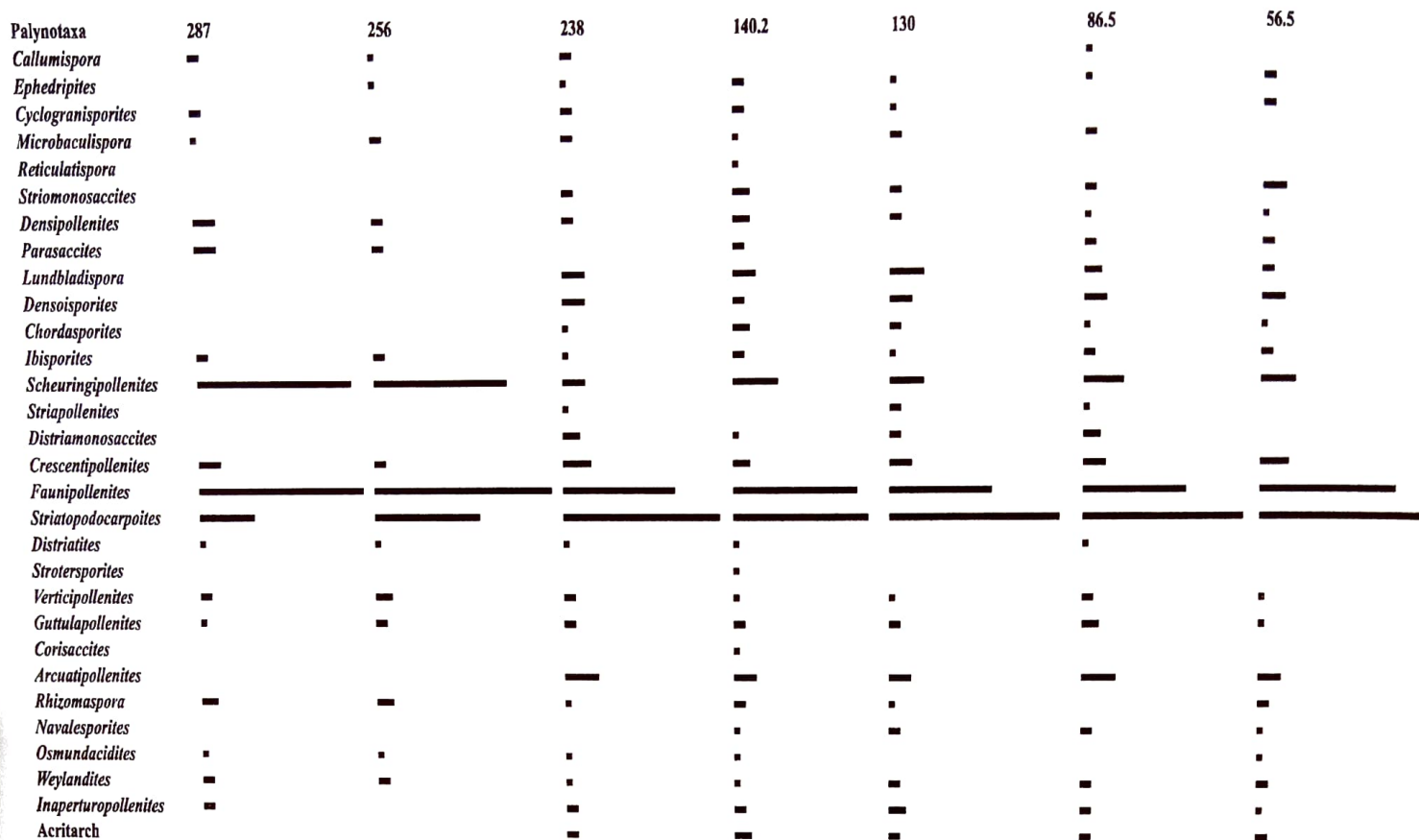


Plate 1



Text-figure 3. Histogram showing percentage frequency and vertical distribution of various palynotaxa in bore hole OIOC-74, Ib River Coalfield, Orissa.

II of Jagaldagga sector, Auranga Coalfield (Jha & Jha 1993); Late Barakar palynoflora of B.H. TP-8, Talchir Coalfield (Tripathi 1996); Assemblage-I of Talchir Coalfield (Meena 2000); and Upper Barakar palynozones of Mand-Raigarh Coalfield (Bhaskaran & Ram-Awatar 2006).

Palynoassemblage-II is akin to Raniganj Formation of Ib River (Tiwari et al. 1991); Palynozone-1 of bore hole IBH-6, Ib River Coalfield (Meena 1999b); Palynozone-2 of Ib River Coalfield (Meena 2000); Bijori Formation of Satpura Basin (Bharadwaj et al. 1978); Raniganj Formation of Damodar Basin (Bharadwaj et al. 1979, Tiwari & Singh 1986); Raniganj palynoflora of Auranga Coalfield (Lele & Srivastava 1979); Pali Formation of South Rewa Basin (Tiwari & Ram-Awatar 1989); Kamthi Formation of Kamptee Coalfield (Srivastava & Bhattacharyya 1996); Assemblage-III of Sohagpur Coalfield (Ram-Awatar 1996); Raniganj Formation of Talchir Coalfields (Tripathi 1997); and Palynoassemblage-II of Pali sediments from Sohagpur Coalfield (Ram-Awatar et

al. 2003). Present palynoassemblage II also correlates with Raniganj palynoflora of different areas of Godavari Graben, viz. Sattupalli area (Palynozone-5, Srivastava & Jha 1994); Bhopalpalli area (Assemblage-I, Srivastava & Jha 1998); Gattugudem area (Raniganj palynoassemblage, Jha 2002); Bottapagudem area (Palynoassemblage-I, Jha 2004); Gundala area (Palynoassemblage-III and Palynoassemblage-IV, Jha & Aggarwal 2010, 2011).

DISCUSSION

In the present study, both palynoassemblages show the dominance of the striate disaccates but subdominance of nonstriate disaccate *Scheuringipollenites* in Palynoassemblage-I (256-287m) distinguishes it from Palynoassemblage-II. On the other hand, the Palynoassemblage-II (238-56.50m) is differentiated from Palynoassemblage-I in having younger elements, viz. *Guttulapollenites*, *Weylandites*, *Arcuatipollenites*, *Lundbladispota* and *Densoisporites*. Palynoflora of Palynoassemblage-I

Table-2 showing lithological details of bore hole OIOC-74.

Sample No.	Depth (m)	Lithology	Palynofossils yield (+++ Abundant; ++ Less: + Very few; - Absent)
1	24.02	Grey shale	+
2	25.00-37.97	Grey shale	-
3	41.50	Grey shale	+
4	45.60	Grey shale	-
5	49.00	Grey shale	-
6	56.50	Grey shale	++
7	77.30	Grey shale	-
8	86.50	Coaly shale	++
9	89.10-91.00	Coaly shale	+
10	99.50	Coal	++
11	100.60-119.50	Carbonaceous shale	+
12	119.90	Coal	-
13	121.50-123.00	Carbonaceous shale	+
14	123.50	Coal	+
15	124.00	Coal	-
16	125.20	Carbonaceous shale	+
17	130.30	Carbonaceous shale	+++
18	133.30-134.20	Coal	-
19	140.20	Carbonaceous shale	-
20	141.50	Carbonaceous shale	+
21	144.10	Coal	-
22	145.10	Shale	-
23	146.00-154.00	Carbonaceous shale	+
24	160.00-163.70	Carbonaceous shale	+
25	222.00	Carbonaceous shale	+
26	223.00	Grey shale	-
27	228.70	Grey shale	-
28	230.00	Carbonaceous shale	+
29	234.00	Carbonaceous shale	+
30	238.00	Carbonaceous shale	+++
31	240.00	Carbonaceous shale	-
32	251.00	Coal	-
33	254.30	Coal	-
34	256.00	Coal	++
35	258.00-266.60	Carbonaceous shale	+
36	269.00	Shale	-
37	270.00	Coal	-
38	276.00	Shale	-
39	283.00	Coal	-
40	287.00	Coal	++
41	288.00	Coal	-

illustrates its affinity with Upper Barakar (late Early Permian) palynoflora while Palynoassemblage-II symbolizes its affinity with Raniganj (early Late Permian) palynoflora.

On the basis of lithological attributes, all the collected subsurface samples (coals) were recognized in Barakar-SupraBarakar formations by Geological Survey of India. But the present palynological study reveals that except 5th seam (Ib seam/contact seam) which has capitulated Barakar palynoflora (Palynoassemblage-I), the rest four overlying seams have yielded Raniganj palynoflora (Palynoassemblage II).

CONCLUSIONS

1. Late Early Permian palynoflora (Upper Barakar) recorded in borecore OIOC-74 indicates presence of Barakar Formation in Brajrajnagar area.
2. Presence of Late Permian (Raniganj) palynoflora indicates presence of Raniganj sediments in area.

ACKNOWLEDGEMENT

Authors are grateful to Dr. N.C. Mehrotra Director, Birbal Sahni Institute of Palaeobotany, Lucknow for his kind permission to publish this paper and to S.M. Vedanayakam, Technical Assistant for the processing of samples and preparation of slides. Authors express their sincere thanks to Dr. Neerja Jha Scientist 'F', BSIP, Lucknow for critical evaluation of the manuscript and for giving constructive suggestions.

REFERENCES

- Anand-Prakash & Srivastava S. C. 1984. Miofloral studies of the Lower Gondwana sediments in Johilla Coalfield, Madhya Pradesh, India. *Palaeobotanist* 32(3): 243-252.
- Bharadwaj D. C., Tiwari R. S. & Anand-Prakash 1978. Palynology of Bijori Formation (Upper Permian) in Satpura Gondwana Basin, India. *Palaeobotanist* 25: 70-78.
- Bharadwaj D. C., Tiwari R. S. & Anand-Prakash 1979. Palynostratigraphy and lithological characteristics in Damodar Basin, India. *Biological Memiors* 4(1-2): 49-82.
- Chakraborty B. & Ram-Awatar 2006. Inter-relationship of the palynofloral assemblages from Mand Coalfield, Chhattisgarh and its significance. *Indian Minerals* 60(3-4): 153-170.
- Jha B. R. & Jha G. 1993. Palynological studies of Permian coals of Jagaldagga Sector of Auranga Coalfield, District Palamu (Bihar). *Minetech* 14(1): 21-28.

- Jha N. 2002. Palynological dating of sediments from Gattugudem Area, Chintalapudi sub-basin, Andhra Pradesh. *Geophytology* 30: 85-89.
- Jha N. 2004. Palynological dating of coal-bearing sediments from the Bottapagudem area, Chintalapudi sub-basin, Andhra Pradesh. *Palaeobotanist* 53: 61-67.
- Jha N. & Aggarwal N. 2010. Early and Late Permian palynoflora from Lower Gondwana sediments of Gundala area, Godavari Graben, Andhra Pradesh, India. *Palaeobotanist* 59: 71-80.
- Jha N. & Aggarwal N. 2011. Palynological evidences for Early and Late Permian sediments in Gundala area of Godavari Graben, Andhra Pradesh, India. *Mem. Geol. Surv. India*.
- Kulshreshtha A. K. 1990. Palynostratigraphy of the Lower Gondwana sediments in Barjora Coalfield, West Bengal, India. *Biological Memoirs* 16(1-2): 18-28.
- Lele K. M. & Srivastava A. K. 1979. Lower Gondwana (Karharbari to Raniganj Stage) miofloral assemblage from the Auranga Coalfield and their stratigraphical significance. In: Bharadwaj D.C. et al. (Editors) - IV International Palynological Conference, Lucknow (1976-1977) 2: 152-164.
- Maiti A. 1994. The palynoassemblage zones of Raniganj Formation (Upper Permian) as revealed from the sub-surface study in Ib River Coalfield, Sundargarh District, Orissa, India. 9th International Gondwana Symposium, Hyderabad 1994: 12 (Abst).
- Meena K. L. 1998. Palynological dating of sub-surface Kamthi sediments in Ib River Coalfield, Orissa, India. *Geophytology* 27 (1-2): 107-110.
- Meena K. L. 1999a. Late Barakar flora reported from Chaturdhara Nala Section from Ib River Coalfield, Sundargarh, Orissa, India. *Palaeobotanist* 48(2): 141-145.
- Meena K. L. 1999b. Palynostratigraphic studies of sub-surface Raniganj Barren Measures sediments from Mand-Raigarh Coalfield, Son-Mahanadi, M.P., India. *Palaeobotanist* 48(3): 217 - 224.
- Meena K. L. 2000. Palynodating of sub-surface sediments of bore-hole IBH-6 in Ib River Coalfield, Orissa, India. *Geophytology* 29 (1-2): 111 - 113.
- Meena K. L. & Goswami S. 2004. Palynostratigraphic studies of Late Permian sediments from Tangadih area, Ib River basin, Orissa, India.
- Ram-Awatar 1996. Palynozonation of Middle Pali Member in Sohagpur Coalfield, Madhya Pradesh. *Palaeobotanist* 43: 96-101.
- Ram-Awatar, Mukhopadhyay A. & Adhikari S. 2003. Palynostratigraphy of sub-surface Lower Gondwana, Pali sediments, Sohagpur Coalfield, Madhya Pradesh, India. *Palaeobotanist* 53: 51-59.
- Srivastava S. C. 1973. Palynostratigraphy of the Giridih Coalfield. *Geophytology* 3: 84-94.
- Srivastava S. C. & Anand-Prakash 1984. Palynological succession of the Lower Gondwana sediments in Umaria Coalfield, Madhya Pradesh, India. *Palaeobotanist* 32: 26-34.
- Srivastava S. C. & Bhattacharyya A. P. 1996. Permian-Triassic palynofloral succession in subsurface from Bazargaon. Nagpur District, Maharashtra. *Palaeobotanist* 43: 10-15.
- Srivastava S. C. & Jha N. 1994. Palynological dating of Lower Gondwana sediments in Sattupalli area, Chintalapudi sub-basin, Andhra Pradesh, India. *Palaeobotanist* 42: 169-173.
- Srivastava S. C. & Jha N. 1998. Palynology of Lower Gondwana sediments in the Bhopalpalli area, Godavari Graben. *J. Palaeontol. Soc. India* 43: 41-48.
- Tiwari R. S. 1968. Palynological investigation of some coal seams in the Ib River Coalfield (Orissa), India. *Palaeobotanist* 16(3): 222-242.
- Tiwari R. S. 1973. Palynological succession in the Barakar type area. *Geophytology* 3(2): 166-183.
- Tiwari R. S. & Ram-Awatar 1989. Spores dispersae and correlation of Gondwana sediments in Johilla Coalfield, Son Valley Graben, Madhya Pradesh. *Palaeobotanist* 37: 94-114.
- Tiwari R. S. & Singh V. 1986. Palynological evidence for Permo-Triassic boundary in Raniganj Coalfield, Damodar Basin, India. *Bull. Geol. Min. Metall. Soc., India* 54: 256-264.
- Tiwari R. S. & Tripathi A. 1992. Marker Assemblage Zones of spore and pollen species through Gondwana Palaeozoic-Mesozoic sequence in India. *Palaeobotanist* 40: 194-236.
- Tiwari R. S., Tripathi A. & Jana B. N. 1991. Palynological evidence for Upper Permian Raniganj Coals in western part of Talcher Coalfield, Orissa, India. *Curr. Sci.* 61: 407-420.
- Tripathi A. 1996. Early and Late Triassic palynoassemblages from subsurface Supra-Barakar sequence in Talcher Coalfield, Orissa, India. *Geophytology* 26(1): 109-118.
- Tripathi A. 1997. Palynostratigraphy and palynofacies analysis of subsurface Permian sediments in Talcher Coalfield, Orissa. *Palaeobotanist* 46: 79-88.