Palynological correlation of Lower Gondwana coal seams

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Correlation of coal seams which is a universally accepted terse geological problem, has been enunciated in all its aspects. The physical and chemical characteristics which are unpredictably variable in coal seams have been evaluated *vis-a-vis* their palynological characteristics which are almost constant qualitatively. These are suggested to be used for typification of each coal seam or its lithological equivalent so as to trace its lateral extension through correlation of the bits and parts occurring in various sectors of the coalfield. As examples of palynotypification, two, recently studied two coal seams from Talcher Coalfield, have been illustrated. One of them is the basal seam in a bore-hole designated as Seam I and interpreted geologically to be of Karharbari Formation. Palynologically it is characterised by the association of *Indotriradites* and *Dentatispora*. The other one is an out-crop seam, so far undetermined geologically. It contains preponderance of *Callumispora*, a spore genus which signifies Karharbari Formation. These coal seams, where so ever their lateral continuations extend, can be identified on the basis of the palynological contents qualitatively and to some extent also quantitatively.

The short-comings and limitations of palynological methodology in the effort to achieve correlation of coal seams have been discussed and ways and means to mitigate the same suggested.

Key-words—Palynology, Correlation, Coal-seams, Karharbari Formation, Lower Gondwana (India).

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साराँश

अधरि गोंडवाना की कोयला-सीमों का परागाणविक सहसम्बन्ध

दिनेश चन्द्र भारद्वाज

एक सर्वमान्य स्पष्ट भूवैज्ञानिक समस्या—कोयला-सीमों के सहसम्बन्ध, का विवेचन सभी पहलुओं को ध्यान में रख कर किया गया है। भौतिक एवं रासायनिक संलक्षणों का, जो कोयला-सीमों में विभिन्नता प्रदर्शित करते हैं, तथा परागाणविक लक्षणों का तुलनात्मक मूल्यांकन किया गया है। प्रायः परागाणविक लक्षण गुणात्मक दृष्टि से स्थिर रहते हैं। अतः प्रत्येक कोयला-सीम अथवा इसके समतुल्य शैलों की प्रारूपता निर्धारित करने में इनका उपयोग प्रस्तावित है ताकि कोयला-क्षेत्र के विभिन्न क्षेत्रों में सहसम्बन्ध के माध्यम से इसका पार्श्व विस्तार खोजा जा सके। परागाणविक प्रारूपता के दो उदाहरणों के रूप में कोयला-सीमों का नवीनतम अध्ययन प्रस्तुत किया गया है। इनमें से एक वेध-छिद्र की आधारी सीम है। यह प्रथम सीम करहरबारी शैल-समूह की है तथा परागाणविक दृष्टि से **इन्डोट्राइरेडाइटिस डेन्टाटिस्पोरा** के साहचर्य से अभिलक्षणित है। दूसरी एक दृश्यांश सीम है जिसका अभी तक भूवैज्ञानिक अभिनिर्धारण नहीं किया जा सका है। इस सीम में **केल्यूमिस्पोरा** की प्रधानता करहरबारी शैल-समूह को इंगित करती है। इन कोयला-सीमों के पार्श्व विस्तार का परागाणुओं के गुणात्मक स्वरूप तथा कुछ हद तक परिमाण के आधार पर भी अभिनिर्धारण किया जा सकता है। कोयला-सीमों के सहसम्बन्धन में प्रयास करने हेतु परागाणविक विधि की सीमाओं एवं कमीयों का विवेचन किया गया है तथा प्रस्तुत समस्या के निराकरण हेतु कुछ उपाय आदि सुझाए गये हैं।

COAL SEAMS correlation has always been a difficult problem for geologists. All the parameters more commonly used in coal prospecting are handicapped by some inconsistency or the other. The thickness of coal seams often varies from place to place and so do the physical and chemical characteristics. Even the so valued coal quality varies, depending upon the extent of metamorphosis the peat undergoes due

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to varied overburden at different locations. A seam of pure coal might become shaly coal or even a carbonaceous shale in various parts of its lateral extent. Thus, crux of this problem is the inability to typify a coal seam which may hold good through out its lateral extent in the coalfield and on the basis of which the seam may be identified all over the area. However, the organic matter contained in the seam and its continuation, being residue of the vegetation growing in or around the basin of deposition, is expected to have been more or less similar all over its extent. This organic residue contains numerous hardy components such as the spores, pollen grains, cuticles and tracheids which are unalterable in their external features or morphography during fossilization. These provide a reliable means of typification for each coal seam irrespective of other differences. Among them, the most varied and distinctive are the spores and pollen grains of the various plant groups. These groups represent evolutionary tendencies acquired by the plant kingdom through geological time. Each of these tendencies is characterised by individualistic reproductive biology including the morphography of the spores and pollen grains, which makes them easily identifiable and classifiable. Thus, spores and pollen grains contained in the fossilized organic debris or coal representing the original vegetation growing in a region at any point of time, provide it a genetic identity. This identity of each coal seam can be traced all over the coalfield through palyno-analysis of samples, i.e., the representation of spores and pollen grains in each sample can be estimated qualitatively and quantitatively.

The principles, as enunciated above, make the problem of coal seams correlation appear very easy. However, in practice it is not so. Inspite of supposed genetic constancy of the palynological contents, the samples from contiguous bore-holes may not compare palynologically and thus, pose problems in correlation—Why?

VARIABLE FACTOR

The theoretically uniform palynological contents of any sediment, may minorly not be so in nature especially in the quantitative representation of spores and pollen grains in the processed samples. This may be due to differential:

1. over representation of some spore kinds due to presence of sporangia, pollen sacs or pollenia in a sample;
2. destruction of some spore kinds due to infiltration or over action of acidic or alkaline medium in the sediments or macerates respectively, thus causing absence of some and consequent over-representation of others in correlatable samples;
3. sedimentary segregation of spores, pollen grains and other micro-remains depending upon the speed and turbulence of the carrying medium resulting into gravitational separation;
4. acumen of palynologists in identifying a spore, pollen grain or its part which may lead to differing results in quantitative estimation.

Realizing the need for reducing the interplay of the above mentioned inconsistencies in interpretation of correlation, varied measures have been practised in palynostratigraphical studies. Differential over-representation is easily over come by preparation of thoroughly mixed samples so as to be representative of the whole or the specific parts of a coal seam.Fortunately, even in finely powdered (70 mesh) sample, small spores and pollen grains remain undamaged. Hence, representative coal samples used for analyses in coal survey laboratories are equally suitable for small spore analysis.

Differential spore destruction due to infiltration of coal deposits by calcareous solutions is known and cannot be mitigated. However, any destruction due to over treatment with acids and alkalies during maceration, is avoided through vigilance and care. Moreover, all abnormal macerations are normally rejected and the process repeated.

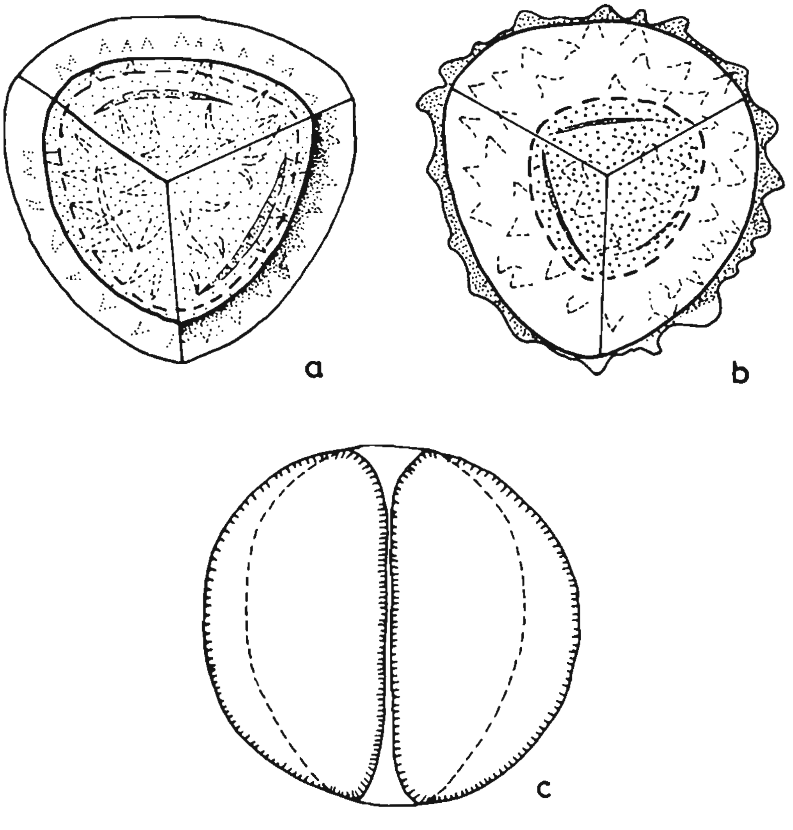
Gravity segregation of spores resulting into unusual representations of certain spore kinds is more theoretical than factual.Further, even if it is sizeable, there is no method of correcting it.

Lastly, to avoid play of the subjective, personality factor, similarity of training, use of broader-based, genealogically coherent taxa as units for quantitative estimation, and interchange of analyses between workers are the remedial measures available.

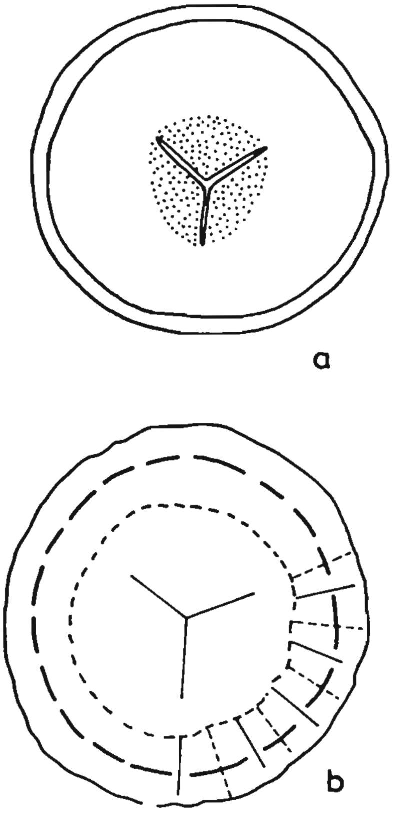
Inconsistency in the lithological nature of coal seams causes difficulties. Hence, to mitigate the lithological variations, all hopeful lithologies besides coal should also be sampled and studied.

CONSTANT FACTOR

While quantitative representation of taxa is minorly variable, the qualitative presence of taxa in each seam is considered constant. Among the gamut of taxa present in the seam a few, even if rare, might be strikingly characteristic and chrono-stratigraphically restricted. Some may be so singly or in association with some others, to make themselves distinctive for that seam. As examples of the same, I report here two cases from our current investigations of Lower Gondwana coalfields from Orissa.



Text-figure 1—Semi-diagrammatic sketches of **A**, *Indotriradites*, **B**, *Dentatispora*, and **C**, *Scheuringipollenites*.



Text-figure 2—Semi-diagrammatic sketches of **A**, *Callumispora* and **B**, *Radial monosaccate*.

Table 1—Suprageneric and generic quantitative representation in two coal seams of Talcher Coalfield

CHAMPARI NALA		SEAM-I, DMTU-026 (216.10 m)	
Callumispora	56%	Smooth Triletes +	
Smooth Triletes	9%	Monoletes	15%
Ornamented Triletes	18%	*Indotriradites*	60%
Zonate Triletes	1%	*Dentatispora*	3%
Nonstriate Disaccates	4%	Nonstriate Disaccates	17%
Radial Monosaccates	11%		
Striate Asaccates	1%	Radial Monosaccates	5%
	100		100

In the sample from Seam I of bore-hole DMTU-26 at 269.50 m level in Talcher Coalfield, a characteristic association of *Indotriradites, Dentatispora* and *Scheuringipollenites* (Text-fig. 1) has been found. The same association has been earlier found (Bharadwaj & Tiwari, 1964) in basal Barakar horizon of Ghordeva Sector in Korba Coalfield. This qualitative as well as quantitative association (Table 1) should now be considered to typify Seam I in Talcher Coalfield. In all the bore-holes in its neighbourhood, any coal seam which contains similar palyno-composition can be identified as Seam I very easily. With this datum fixed, it would be possible to characterise the preceding and the succeeding strata also.

The second sample is from a seam outcrop in Champari Nala of Talcher Coalfield. It contains an association of *Callumispora* and radial monosaccates (Text-fig. 2) and some ornamented small triletes. This assemblage compares closely with that of Lower Karharbari of Korba Coalfield (Bharadwaj & Srivastava, 1973) and should identify the lateral continuations of Lower Karharbari sediments in the Talcher Coalfield. I believe that the Champari Nala seam is the first palynologically authenticated record of a Karharbari seam in Talcher Coalfield.

The palynological characteristics of both these samples are distinctive singly because each represents a separate zone but to establish the diagnostic palynocombination, the whole sequence lying above and below needs to be qualitatively and quantitatively palyno-analysed. Hence, the first step to be taken in the palynological study of any coalfield is the detailed, generic level palynoanalysis of at least one (Table 2) closely sampled (including all lithologies), regional or deep bore-hole, containing the whole of coaliferous sequence, from

Table 2—Percent frequency chart of Sporae dispersae in bore-hole no. BOR/MA/043

(All levels are typified by different combinations of genera with % represented in bold figures).

Sample No.	Depth (M)	Lithology	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
125	14.94	Carb. Shale	—	2.0	0.5	**5.5**	—	0.5	—	1.5	—	—	1.0	1.5	—	—	1.0	**8.0**	3.0	5.0	2.0	21.5
133	20.50	Sandy Shale	0.5	1.0	—	1.5	2.0	—	—	1.5	3.0	—	—	1.0	1.0	—	—	5.5	—	2.5	1.0	**31.5**
136	25.00	Coal	—	—	—	—	0.5	—	—	—	—	—	0.5	—	0.5	—	—	8.0	1.0	2.0	1.0	22.0
142	42.90	Coal	0.5	3.0	—	**7.0**	3.5	0.5	1.0	1.0	**7.5**	—	1.5	0.5	1.0	—	—	5.0	—	5.0	1.5	**28.0**
145	45.25	Coal	—	1.5	—	3.0	1.5	—	—	1.0	2.5	—	0.5	**4.5**	—	—	0.5	2.0	1.0	3.0	3.5	**28.0**
152	50.35	Alternating shale and sandstone	—	0.5	—	1.0	0.5	—	—	0.5	0.5	—	—	0.5	—	—	—	4.0	—	1.0	1.0	28.0
158	73.29	Shaly SST.	1.0	1.5	—	1.5	1.5	—	—	0.5	1.0	—	—	0.5	—	0.5	1.0	**13.0**	1.0	4.0	**8.0**	16.0
167	94.40	Coaly shale	—	0.5	—	1.5	—	—	—	—	—	—	—	—	—	1.0	0.5	5.5	3.5	**6.5**	**7.5**	24.0
173	100.45	Coal	—	1.5	—	1.0	0.5	—	—	—	1.0	0.5	—	1.0	—	—	—	7.5	—	**7.5**	5.5	20.5
177	109.94	Shale	—	2.5	—	3.0	4.0	1.0	0.5	1.0	2.0	—	1.5	1.0	2.0	—	—	3.0	2.0	**3.0**	5.0	18.5
182	115.40	Shaly SST.	—	1.0	—	1.5	2.5	0.5	—	—	—	—	1.0	—	—	1.0	0.5	4.5	2.0	5.5	2.0	20.5
	120.77	Metamorphic																				
	126.00	Bore-hole closed																				

Contd.

			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total
			3.0	0.5	2.5	1.0	—	3.0	—	26.0	—	1.0	6.0	1.0	2.0	—	0.5	0.5	—	—	—	100
			1.0	—	1.0	—	1.0	—	—	**32.5**	1.5	3.0	7.0	—	—	—	—	0.5	0.5	—	—	100
			1.0	1.5	**7.0**	1.5	—	2.0	—	**32.5**	2.0	—	12.0	1.0	2.0	—	—	0.5	—	1.5	—	100
			—	0.5	0.5	—	—	—	—	26.5	—	1.5	3.0	—	1.5	—	—	—	—	—	—	100
			—	2.5	1.5	—	—	1.0	—	**28.0**	—	3.5	10.5	—	—	—	0.5	—	—	—	—	100
			—	**5.0**	1.5	0.5	—	3.0	—	**31.5**	1.0	3.0	11.5	2.0	2.0	—	—	0.5	—	1.0	—	100
			2.0	1.5	0.5	0.5	—	3.0	1.0	17.0	2.0	3.0	12.0	1.0	4.0	—	1.5	0.5	0.5	—	—	100
			1.5	—	—	—	—	**3.5**	—	26.5	1.5	3.5	7.5	—	3.5	—	1.0	—	—	—	1.0	100
			5.0	—	—	—	0.5	3.0	—	24.5	—	4.0	8.5	2.0	4.0	0.5	—	0.5	0.5	0.5	—	100
			3.0	0.5	—	0.5	1.0	2.0	**3.0**	24.5	1.0	**4.0**	5.5	—	5.0	—	—	—	—	—	—	100
			3.0	3.5	0.5	—	—	3.0	**4.5**	20.5	1.0	3.0	9.0	2.0	**5.5**	0.5	1.0	0.5	—	—	—	100

1, *Acanthotriletes*; **2**, *Apiculatisporis*; **3**, *Cyclobaculisporites*; **4**, *Cyclogranisporites*; **5**, *Horriditriletes*; **6**, *Imparitriletes*; **7**, *Lacinitriletes*; **8**, *Leiotriletes*; **9**, *Lophotriletes*; **10**, *Microbaculispora*; **11**, *Microfoveolatispora*; **12**, *Latosporites*; **13**, *Thymospora*; **14**, *Parasaccites*; **15**, *Plicatipollenites*; **16**, *Cuneatisporites*; **17**, *Labiisporites*; **18**, *Ibisporites*; **19**, *Platysaccus*; **20**, *Scheuringipollenites*; **21**, *Vesicaspora*; **22**, *Striamonosaccites*; **23**, *Striasulcites*; **24**, *Tiwariasporis*; **25**, *Striapollenites*; **26**, *Crescentipollenites*; **27**, *Distriatites*; **28**, *Faunipollenites*; **29**, *Lahirites*; **30**, *Striatites*; **31**, *Striatopodocarpites*; **32**, *Verticipollenites*; **33**, *Rhizomaspora*; **34**, *Maculatasporites*; **35**, *Densipollenites*; **36**, *Ginkgocycadophytus*; **37**, *Schizopollis*; **38**, *Weylandites*; **39**, *Praecolpatite*.

each sector. This study would typify each coal seam on the basis of quantitatively significant association of atleast two genera, besides revealing the trend of palynological changes in geological time from the base to the top of depositional sequence. The palyno-analyses of other bore-cores can be referred to this standard profile and lateral correlations suggested. Such an information would help the geologist incharge in final interpretation of coal seams correlation, fault throws and coal potential.

SEAM SPLIT

The problem of seam split often creates difficulties in coal seams correlation. Palynologically a coal seam should be qualitatively and quantitatively constant at one location. Hence, between contiguous bore-boles a seam, even if split, can be identified through palynological comparison. In cases of seams which are thicker than 3 m, it is preferable to sample it in two or more parts so that the differences if any, occurring due to extended duration of deposition, may be revealed and taken into account for interpretation.

CONCLUSIONS

Although comprehensive palynological studies on correlation of coal seams in Lower Gondwana coals (Bharadwaj *et al.*, 1964, 1965, 1966, 1968, 1969a, 1969b, 1970, 1971) have been carried out in the past to understand and evolve the know-how for this difficult problem, certain aspects still need further studies for enhanced refinement and precision. Nevertheless, we may conclude about the stratigraphical value of various palynological units as follows:

Units	*Stratigraphy*
Geneologically coherent supra-generic units in quantitative combination	Zones
Morphographically coherent generic units in qualitative combination	Subzones
Generic units in quantitative combination	Stratum correlation

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