SOME OBSERVATIONS ON POLLEN FOUND IN INDIAN TERTIARY LIGNITES*

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ABSTRACT

Attention is drawn to the occurrence of some similar *types* of pollen, spores and possible microthyriaceous remains in some of the Tertiary lignites of India like those of Palana, Warkalli and S. Arcot and in the Deccan Intertrappean Series. The pollen have been provisionally compared to the genera like *Potamogeton, Betula, Fraxinus, Borassus, Tilia, Protea, Carya, Carpinus, Quercus* and *Schizaea* which might well have been the common components of the different Tertiary floras of India. The Indian Tertiary vegetation thus included families like the Proteaceae, Juglandaceae, Tiliaceae, Palmae, Fraxineae, Betulaceae, Potamogetonaceae and Schizaeaceae, and was probably uniform. Some of the above-mentioned pollen and spore types and particularly the Microthyriaceae occurring in Indian Tertiary lignites are also found in Australia. This fact not only points to the wide distribution of some genera during the Tertiary period but also indicates that the climate was also probably similar in these widely separated regions.

INDIAN lignites have not received the attention they deserve from palaeobotanists. Recent studies on some lignites from Palana (RAO & VIMAL, 1950, 1952; VIMAL, unpublished data) in Bikaner, Dandot in the Salt Ranges (VIMAL, 1952), Warkalli in Travancore (RAO & VIMAL, 1952a; VIMAL, 1953) and Cuddalore in South Arcot (JACOB & JACOB, 1950; VIMAL, unpublished data) Madras State, have brought to light the wealth of pollen and spores that lie hidden in these lignites. Although it has been comparatively easy enough for me and Mr. Vimal to describe these pollen and spores found in the lignites studied by us, referring them to their systematic position has been an exceedingly difficult task. The absence of any literature or herbaria or museum of pollen material of Indian living plants has been a serious handicap. In fact even the data in general regarding the pollen and spores of living plants are very variable, conditioned by the age of the plant, the time of collection, certain environmental factors like soil, water, location, climate, etc. In case of fossil pollen the position is still worse. Defective and insufficient preservation render general and statistical studies of these pollen very difficult. The wide range of variation seen in living pollen cannot always be observed in fossil pollen. The finer morphological features like the exine and intine characters and surface sculpturing may not be fully preserved. The comparison of these pollen and spores in the above-mentioned Indian tertiary lignites has thus been very difficult indeed. Still, with the help of the very valuable works of Wodehouse and Erdtman on living pollen, certain provisional comparisons have been made when sufficiently reliable and convincing morphological data like spore form, furrows, pores, surface sculpture, dimensions, etc., have been forthcoming. On the basis of these criteria and following the classification of Erdtman these pollen and spores have also been classified and figured. The descriptive terminology employed in this work also borrows largely from Selling (1946, 1947), Erdtman (1943, 1947, 1952) and Wodehouse (1935). It has already been pointed out that there was no other alternative but to compare these pollen and spores with their possible living counterparts no matter what part of the world they came from. The works of Wodehouse, Selling, Erdtman, Sears, Potonie, Cookson and several others were indeed very helpful. It is but natural that in such a large-scale comparison with extra-Indian flora the identifications may not be very accurate generically, although satisfactory so far as the natural orders are concerned. But this is unavoidable until we have in India an indigenous pollen herbarium or collection preserved according to standard techniques and recorded and illustrated according to certain conventional descriptive terminology and illustration. The distinguished palynologist Erdtman has shown

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us the way to do this. An exhaustive and intensive study of living pollen types of our country is an indispensable prerequisite to the study of fossil pollen. Accordingly we have refrained from making any large-scale comparisons or giving the pollen and spores definite generic names. During the course of this work it was noticed that certain types of pollen are represented in all the different lignites while others are not. Some of these common types are of great interest as they serve to indicate some reliable and common components of the tertiary vegetation of India. Their occurrence in not only Indian but also extra-Indian tertiary deposits like those of Australia (whose microflora has been investigated) is important and significant, and it is just to some of these common types that I will confine my attention in this brief note. They render the task of comparison easy and help in verifying the age of fossiliferous beds. Certain general inferences regarding the nature of the flora, its composition and generic representation have already been made in the papers referred to above (*see* RAO & VIMAL and VIMAL). It has also been pointed out in the above papers that the identification — provisional as it is — is of only a fraction of the large number of pollen and spores found in the lignites. A significant fact that has emerged from our study of these lignites is the absence in all of them, so far at least as has been studied, of any type of Conifer pollen — particularly of the winged type. Pteridophytic spores seem to be in very small proportions to the entire microfossil flora. It was evidently a dominatingly angiospermous vegetation that went to form these lignites. Most of the pollen seem to be of the arborescent types.

Plate 1 indicates the various *types* of pollen arranged in serial order. Their possible generic comparisons are also indicated. The corresponding types in each lignite deposit is also figured (either in an equatorial or polar view) in horizontal series. Their size, shape and surface features and exine characters are also indicated alongside of the figure. In spite of the variations found on these points they probably belong to the same type, perhaps family, but may or may not belong to the same genus. Of course varying modes of preservation may give rise to contradictory appearances and varying dimensions even in the same type or species of spore. A general perusal of the table at once shows that the *nonaperturites* type, the *tricolpites* type, the *triorites* types and the microthyriaceae occur in all the four lignites. The *hexacolpites* type occur in all but the South Arcot lignites. The *tetracolpites* and the *monoletes* types appear to be absent from the Warkalli lignites. The above conclusions are not in any sense categorical. It is most likely that the types missing in their respective lignites have only not yet been observed so far. Their presence, if discovered later, would only add to the list of types that are common to all the lignites. The greatest measure of agreement is found in the *nonaperturites*, the *triorites*, the *tricolpites* and *tetracolpites* types, and, on the whole, the *Colpites* seem to dominate.

Amongst the *nonaperturites* type is only one type of pollen provisionally referred to *Potamogeton*. The *tetracolpites* and *pentacolpites* include types referred to *Fraxinus* (which may be penta or tetracolpate) and one tetracolpate type is referred to *Tilia*.

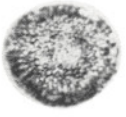
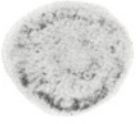
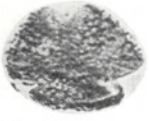
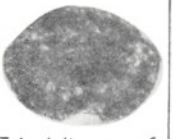
The *monocolpites* type includes grains which can be referred to the palms *Borasssu* and *Pritchardia*, the former genus being present in the present-day flora of India.

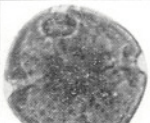
A *triorites* type of pollen has been referred to the genus *Betula* and this occurs in all the Indian lignites and in the Deccan Eocene flora. Another *triorites* grain found so far only in the Palana lignites resembles the grains of the Proteaceae. This type of grain is also reported from Australian tertiary deposits.

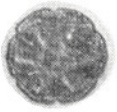
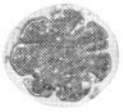
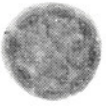
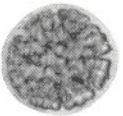
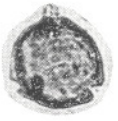
The *tricolpites* are represented by *Quercus* and *Carpinus* types of pollen. An unidentified *triletes* spore occurs in all the lignites and in the Eocene Deccan traps. A *triporite Carya*-type of pollen is also found in the South Arcot deposits.

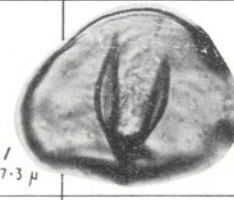
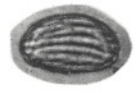
A *monoletes* type of sporomorph found in Palana and South Arcot can be referred to the Schizaeaceae.

It is necessary to make it clear here that the occurrence in these lignites of corresponding types of pollen and spores as shown in the Plates does not in any way assert specific or generic identity between them although it may be present. They simply indicate the existence of similar generic *types*. In the absence of a local pollen herbarium these fossil pollen and spores have naturally been compared with published illustrations and descriptions of extra-Indian present-day flora and have been referred provisionally to genera more as a method of

Type number	Type	Dandot (Pakistan) Eocene Vimal 1952	Palana (India) Eocene Rao & Vimal/1950 Rao & Vimal/1952	Warkalli (India) Miocene Rao & Vimal/1952 Vimal 1953	South Arcot Cuddalore (India) Miocene Vimal Mss	Deccan Intertrappean Eocene Chitaley 1951/1952	Green River U.S.A.	Australia
1	*Nonaperturites* *?Potamogeton*	 *Subpilonapites spm1* Spherical 38·1 µ x 41·6 µ	 *Nonaperturites spm1* Flat 41·6 µ Verrucate	 *Verruconapites spm1* Oblate 41·6 µ Verrucate	 *Nonaperturites spm1* Flat 35·7 µ Baculate		+	
2	*Monocolpites* *Palmae* *?Borassus* *?Pritchardia*		 *Monocolpites spm2* 12 µ x 29 µ Flattened Smooth	 *Monocolpites spm 1* 33·3 µ x 20·2 µ Smooth	 *Monocolpites spm 1* Flat 38 µ x 20 µ Smooth	+		
3	*Tricolpites*	 *Tricolpites spm 3* Oblate 53·5 µ x 47·6 µ Positively reticulate	 *Tricolpites spm 8* Subprolate 25 µ Positively reticulate	 *Tricolpites spm 6* Flattened 44·1 µ x 57·1 µ Positively reticulate	 *Tricolpites spm 1* Suboblate 29·3 µ Positively reticulate		+	
4	*Tricolpites* *?Quercus*		 *Tricolpites spms 1,3* Prolate 28·8 µ x 34·6 µ	 *Tricolpites spm 5* 13·1 µ Smooth	 *Tricolpites spm 4* 19 µ granular			

Type number	Type	Dandot (Pakistan) Eocene Vimal 1952	Palana (India) Eocene Rao & Vimal 1950 Rao & Vimal 1952	Warkalli (India) Miocene Rao & Vimal 1952 Vimal 1953	South Arcot Cuddalore (India) Miocene Vimal Mss	Deccan Intertrappean EOCENE Chitaley 1951 1952	Green River U.S.A.	Australia
5	*Tricolpites*		 *Tricolpites spm 25* Prolate prolate spheroidal 17·9 μ reticulate		 *Tricolpites spm 6* Prolate 17·9 μ Reticulate			
6	*Tetracolpites* ? *Fraxinus*	 *Tetracolpites spm 1* Flat 35·7 μ Finely scrobiculate	 *Tetracolpites spm 1* Flat 22·4 μ x 24 μ granular		 *Tetracolpites spm 1* Suboblate 29·7 μ granular		+	
7	*Tetracolporites* ? *Tilia*		 *Tetracolporites spm 1* Suboblate 44·5 μ x 48·7 μ Smooth		 *Tetracolporites spm 1* Oblate 41·6 μ x 38·1 μ Smooth		+	
8	*Pentacolpites* ? *Fraxinus*		 *Pentacolpites spm* Flat 28·5 μ granular		 *Pentacolpites spm 1* Oblate 35·7 μ granular			

Type number	Type	Dandot (Pakistan) Eocene Vimal 1952	Palana (India) Eocene Rao & Vimal 1950 Rao & Vimal 1952	Warkalli (India) Miocene Rao & Vimal 1952 Vimal 1953	South Arcot Cuddalore (India) Miocene Vimal Mss	Deccan intertrappean Eocene Chitaley 1951 1952	Green River U.S.A.	Australia
9	*Hexacolpites*	 *Hexacolpites spm 4* Discoid 38·1 μ Densely granular	 *Hexacolpites spm I* Oblate 35·5 μ granular	 *Hexacolpites spm I* Oblate 38·1 μ granular				
10	*Septacolpites and Octacolpites*	 *Septacolpites spm I* Discoid 35·7 μ granular	 *Octacolpites spm I* 31·5 μ granular		 *Octacolpites spm I* Oblate 40·0 μ granular			
11	*Triorites* ? *Proteaceae*		 *Triorites spm 3* Flat 25 μ x 30 μ Smooth granular					+
12	*Triorites* ?*Carpinus*	 *Triorites spm 3* Flat 40·4 μ x 42·8 μ surface granular	 *Tricolpites (?Triorites) spm II* Flat 35·7 μ granular	 *Triorites spm 4* 45·3 μ x 40·4 μ oblate spheroidal smooth granular				
13	*Pentaorites or Septaorites*		 *Pentaorites spm I* oblate 31 μ smooth		 *Septaorites spm I* 20 μ - 30 μ smooth			

Type number	Type	Dandot Pakistan Eocene Vimal 1952	Palana (India) Eocene Rao & Vimal 1950 Rao & Vimal 1952	Warkalli (India) Miocene Rao & Vimal 1952 Vimal 1953	South Arcot Cuddalore (India) Miocene Vimal Mss	Deccan Intertrappean (Eocene) Chitaley 1951 1952	Green River U.S.A.	Australia
14	*Triorites* ?*Betula*	 *Triorites spm 2* Flat 28·5 x 23·3 μ Slightly granular	 *Triorites spm 1* oblate sheroidal 20·2 μ smooth	 *Triorites spm 1* suboblate 17·9 μ smooth	 *Triorites spm 6* suboblate 17·9 μ smooth	+	+	
15	*Triporites* ?*Carya*				 *Triporites spm 1* oblately flattened 19 μ - 50 μ smooth granular		+	
16	*Triletes*	 *Triletes spm 8* 41·6 μ x 50 μ Flat	 *Triletes spm 3* Flat 50 μ smooth	*Triletes spm 1* Flat 69 μ x 77·3 μ smooth		+		
17	*Monoletes* ?*Schizaeaceae*		 *Monoletes spm 1* Flat 42 μ x 24 μ Surface striated		 *Monoletes spm 7* Flat 30·9 x 48·8 μ Surface striated			
18	*Microthyriaceae*	+	+	+	+	+		+

classifying them conveniently rather than as suggesting any definite generic or specific relationships. Yet even if this indirect and limited comparison stands on secure data regarding the size, shape and other morphological features (well within the range of variation), there is no reason why the pollen should not provisionally be compared to, though not definitely referred to, certain *genera*. This has indeed been the attitude adopted all along the course of this work and judged in this manner it may be said that the Potamogetonaceae, Betulaceae, Fraxineae, Palmae, Tiliaceae, Proteaceae, Juglandaceae were represented in the tertiary flora of India, and that genera like *Potamogeton, Betula, Fraxinus, Borassus, Tilia, Protea, Carya, Carpinus, Quercus* and *Schizaea* were probably common components of this tertiary vegetation, whether of the Eocene or Miocene age. Similar types of pollen occurring in these different beds indicate that the flora in these were not very sharply defined from each other but that there were many common types and that the flora was on the whole rather uniform. The microthyriaceae are also represented in all the lignites as well as in the Eocene deposits of the Deccan traps (CHITALEY, 1951a). Some of these are remarkably like those described by Miss Cookson (1947) from Australian tertiary deposits. The occurrence of similar types of pollen and also these microthyriaceae in all the different tertiary deposits studied above and also in the tertiary deposits of Australia is significant. It also confirms the presence and wide distribution of the Microthyriaceae in the Eocene and Miocene periods in India and incidentally suggests that similar climatic conditions — probably warm humid type — as suggested by the presence of palms and absence of conifers, prevailed in these widely separated regions.

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