AFFINITIES OF SOME INDIAN TERTIARY AND QUATERNARY POLLEN AND SPORES

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INTRODUCTION

THE late Prof. Sahni indicated the significance of pollen and spore microfossils in considerations of the extinct floras, past climates, and the stratigraphy of coals and lignites (Sahni, 1938). The microscopic examination of coal in India started with Lomax (1927), and in later years, pioneering contributions have been made by Banerji (1932) and Virki (1937 and 1946). At the same time Wodehouse (1935) analysed the pollen flora of the Pleistocene deposits of Kashmir. Since then, a large number of spores have been described, illustrated, and classified into artificial categories, covering the entire geological time, from Palaeozoic to the Recent. The Palaeozoic, Triassic, and Jurassic ‘Sporae dispersae’ belong to the extinct plants, although some of them might have their equivalents among the present day plants. But the Tertiary and later Floras should be considered to bear closer affinities to the modern Flora, and the fossil pollen and spores recovered from those strata indicate the extent of such affinities. The various Indian workers were unable to recognise and identify of the plants represented by the fossil spores and pollen, due to the paucity of our knowledge on the morphology of the spores and pollen of the present day plants (Rao, 1955). In recent years much work has been carried out in this direction (Erdtman, 1952, and 1957; Nair, 1961, 1962, 1962a, 1962c; Nair and Sharma, 1962 and Nair and Rehman, 1962; Nayar and Kaur, 1963; Nayar and Shantha Devi, 1963) which has paved the way for the present attempt to suggest* the possible affinities of the fossil spores and pollen known from the Tertiary and later periods of India with their present day equivalents. It should be noted that the comparisons of the fossil spores and pollen given here relate only to the type grain considered, and this identity does not necessarily apply to grains known under the same form genera from earlier horizons.

ARRANGEMENT

In making the foregoing suggestions, the literature on the subject is classified in relation to the geological period they refer to. The pollen and spore types are arranged in the same order as given in the cited reference, and indications on the possible identity (one or more are given when the identity is provisional) are made against the name of each type. In the present communication, only those sporomorphs for which the identity could be suggested are considered, and also the observations are based on the photomicrographs, text-figures, and descriptions of pollen and spores recorded in every research contribution.

* The author wishes to record that in making these suggestions he is not criticising the observations made by any individual worker. On the contrary, the present suggestions are based in every case on the descriptions given by the author concerned.
Comparisons

I. TERTIARY
(A) Locality—VARKALI, TRAVANCORE (Kerala).

Microflora
Monolites—Sp. 1: Polypodiaceae (Pyroseria).
Triorites—Sp. 1: Urticaceae (Morus)
Tricolpites—Sp. 1: (Apparently tricolpites with a faint orad; see photo 5; ? Leguminosae).
Hexacolpites—Sp. 1: (Euphorbiaceae.
H. Sp. 2:

Microflora
Monolites—Sp. 2: Polypodiaceae (?Pleopeltis)
M. Sp. 3: Polypodiaceae.
Triletes—Sp. 1: Osmundaceae.
Nonaperturites—Verrucanopites—Sp. 1: (Grain possibly reticulate; ? Potamogetonaceae; ? Potamogeton; very much close to P. crisperus).
Monacolpites—Sp. 2: Palmae (not Borass as compared, because the genus has verruca grains, which is lacking in the specimen described here).
T. Sp. 3: (Apparently tricolpites; see Pl. IX, Fig. 15; ? Simarurubea; ? Allianthus).
T. Sp. 4: (Apparently tricolpitate; see Pl. IX, Fig. 17).
Tetralcolpites—Sp. 1: (Apparately tetralcolpites; see Pl. IX, Fig. 20; Meliaceae).
Hexacolpites—Sp. 1: (Euphorbiaceae).
Octacolpites—Sp. 2: Rubiaceae (Rubus or Galium).
Tricolpites—Sp. 1: Leguminosae (Tri-
folium, Lotus, Medicago etc.).
Tetralcolpites—Sp. 2: Euphorbiaceae.

Microflora
Type 1: Rubiaceae (Rubus or Galium).
Type 4: Leguminosae (? Erithrina).
Type 6: ? Meliaceae.
Type 7: Ranunculaceae.
Type 8: (Possibly 1-colporate, lateral view; Palmae).
Type 10: ? Caprifoliaceae.

Microflora
Type 1: Ophioglossaceae (Ophioglossum).
T. Sp. 2: Lycopodiaceae (Lycopodium).
T. Sp. 5: Pteridaceae (? Cheilanthes).
T. Sp. 6: Osmundaceae.
T. Sp. 10: (Pollen tetrad; Possibly of Typha).
Nonaperturites—subpilonapites—Sp. 1: Potamo-
geton.)
N. reticolapites—Sp. 1: Same as above.
M. Sp. 2: ? Potamogeton (1-colpate grains often found in the living species also).
T. Sp. 3: Polygonaceae (? Polygonum).
T. Sp. 4: Cruciferae.
T. Sp. 5: Nymphaeaceae (? Nelumbo.)
Tetracolpites—spm. 1: Oleaceae (? Fraxinus).
Hexacolpites—spm. 1: Labiatae.
H. spm. 2: Rubiaceae (Rubus or Galium).
H. spm. 3: Labiatae.
T. spm. 2: Betulaceae (? Betula).
T. spm. 3: Betulaceae (? Carpinus).

(D) Locality—Deccan intertrappean.

Microflora
Monoporites (Graminites) minor: Gramineae.
Tetrado-monoporites (Typhidites) spm. Typha.
Monosulcites (palmitides) minima M. (P) media.
M. (P) spinosa: Palmae (? Borassus).
Triorites (Betulacidites) spm. (Possibly Alnus, if arci is sharp as described).
Porites spm. Compositae (Cichoreae: Sonchus, Crepis etc.).
(E) Locality—Assam

Microfossil
The author described a 2-winged, pollen compared to that of the Podocarpaceae.

Microflora
The author compared a few grains to Magnolia (Type G), Phoenix dactylifera Type G1) and Cupressaceae (Types N and O). In the absence of photomicrographs the identification of sporomorphs is made difficult. However, there are indications of Larix (Type H), and Borassus (Type I) in the flora.

In the absence of photomicrographs and complete descriptions of sporomorphs no proper identity could be established. However, the drawings given could be compared to the grains of Selaginella (Pl. XVII, Fig. 47), Pitoyrogramma (Pl. XVI, Fig. 37), Drymoglossum (Pl. XVI, Fig. 44) among pteridophytes, and Compositae (Pl. XIV, Fig. 18), Betulaceae (Pl. XIV, Fig. 19), Pinaceae (Pl. XV, Fig. 36 and 29), Labiatae (Pl. XV, Fig. 27), and Urticaceae (Cannabis; Pl. XVI, Fig. 35), among the higher plants.

(F) Locality—Kashmir

Microflora
Polypodiacaesporites (Thierg.) haardt : Poly-
podiacae (? Microsorum ; Platycerium).
Psuedoschizaea ozeanica : ?
Cyathidites kashmirensis : Cyatheaceae.
Abies pollenites (Thierg.) kashmirensis : Pine-
ceae (Abies).
Polyborina kashmirensis : ? Chenopodiaceae or Amarantaceae.
Quadrasus indicus : Fig. 15, very close to A. nipalensis; arcus not clear in Fig. 16; possibly Urticaceae.
Triorporocolaptus indicus : ? Fagaceae. (Quercus).
Umbelliferoidae pollenites kashmirensis : Umbel-
iferae.
Triorporus kashmirensis : Betulaceae (Betula).
Tubulifloridites (Cookson) Kashmirensis : Compositae.
(G) Locality—Cannanore, Malabar coast

Microfossil
Monoletes sp. (Pollen grain in equatorial view, see Pl. VII, Fig. 37; very close to Acanthaceae).
Polypodiidites impariter : Polypodiaceae
(?) Pleopeltis.
Limitisporites sp. : ? Pinaceae (? Cedrus).
Monosulcites parvus : Palmae (? Phoenix).
Cupuliferopollenites sp. : Fagaceae (? Casta-
neopsis).
Monoporopollenites minimus : Gramineae (some
grains, Pl. VII, Fig. 35, very close to Cyperaceae).
Polyadopollenites multifidus : ? Orchidaceae.
(H) Locality—Cuddalore, Madras State, S. India
Microflora
The author has made comparison of the fossil sporomorphs to living plants belonging to Caprifoliaceae, Cruciferae, Euphorbiaceae, Gentianaceae, Meliaceae, Ranunculaceae, Santalaceae, Gramineae, Liliaceae, and Poly podiaceae.

IV. Miocene
Locality—Kutch

Microfossil
The authors observed the occurrence of Dipterocarpus in the deposit.

V. Pleistocene
Locality—Kashmir (Karewas).
Pollen grains recovered have been directly placed under their living equivalents (see under Analysis of microflora).

ANALYSIS OF MICROFLORA
Rao (1955) made some observations on the composition of the flora represented by the pollen and spores occurring in Indian Tertiary lignites. But his inferences were based on "provisional comparisons" of the microfossils to their possible living equivalents, thereby providing room for a reconsideration of the Indian Tertiary vegetation. Also, inferences on the nature of the flora and the climate have been drawn regarding the Quaternary (Karewas) of Kashmir (Wodehouse, 1935; Nair, 1961). But for the above, there has not been any serious attempt to evaluate the evidences presented by the pollen and spore fossils, mainly due to the difficulties encountered in the matter of identifying the plants represented by those microfossils. However, an insight into the nature and composition of the Indian Mesozoic and Cainozoic floras is made possible by the present attempt to associate the pollen and spore form genera to respective taxa of (living) plants.

TERTIARY FLORA.
Rao (1955) indicated the similarity of Tertiary floral assemblages from Varkalli (Kerala), Dandot (Pakistan) and Palana (Rajasthan), and also noted the affinity of the Indian flora to the corresponding Australian flora. Apart from the above localities, microflora from the Deccan Intertrappean, Assam, Kashmir, Cannanore (Malabar), and Cuddalore are known and the constituents of the flora are as follows:

Pteridophyta
Cyatheaceae, Lycopodiaceae (Lycopodium), Ophioglossaceae (Ophioglossum) Osmundaceae (Osmunda), Polypodiaceae (Drynoglossum, Microsorium, Platycerium, Pleopeltis, and Pyrrosia), Pteridaceae (Cheilanthes, Lindseaa, Microlepis and Pitroygroma) and, Selaginellaceae (Selaginella).

Gymnospermae
Pinaceae (Abies, Larix, and Pinus) and Podocarpaceae (Podocarpus).

Angiospermae
Acanthaceae, Betulaceae (Alnus, Betula and Carpinus), Boraginaceae, Caprifoliaceae, Casuarinaceae (Casuarina), Chenopodiaceae (Chenopodium), Compositae (Launae, Sonchus, Asteroideae), Cornaceae (Cornus), Cruciferae, Cyperaceae, Euphorbiaceae (Phyllanthus), Fagaceae (Castaneopsis and Quercus), Gentianaceae, Gramineae, Labiatae, Leguminosae, (Trifolium, Lotus, Medicago etc; Erythrina), Liliaceae, Magnoliaceae, Nymphaeaceae (Nelumbo), Oleaceae, Orchidaceae, Palmae (Borassus and Phoenix), Potamogetonaceae (Potamogeton), Ranunculaceae, Rubiaceae (Rubus, Galium etc.), Salicaceae Santalaceae, Simarubaceae (Ailanthus), Tiliaceae (Tilia), Typhaceae (Typha), Umbelliferae, and Urticaceae (Cannabis, Debregesia and Morsus). The floral assemblages of each locality are as follows:

(i) Varkalli, Travancore (Kerala): Osmundaceae, Pleopeltis, Pyrrosia and other Poly podiaceae, Boraginaceae, Casuarina, Chenopodium, Meliaceae, Phyllanthus, Legumnoi-
Pleistocene flora

The knowledge about the Indian Pleistocene flora is confined to the Karewa formations, Kashmir. The flora is known (Wodehouse, 1935; Nair, 1960) to consist of the following plants:

Gymnosperms: Abies, Cedrus, Larix, Picea, Pinus, Cupressus, and Ephedra.

Angiosperms: Alnus, Artemisia, Azadirachta, Betula, Carpinus, Cheirodendraceae, Compositae, Corylus, Fraxinus, Gramineae, Juglans, Jussiaea, Maoutia, Maclura, Myriophyllum, Nelumbo, Pterocarya, Plantago, Polygonum, Pteridium, Pulsatilla, Quercus, Rhus, Salix, Trips, Typha, Ulmus, Umbeliferae, Utricularia, Valeriana, and Viburnum.

From the palynological data, it has been observed that in the lower Karewas there was possibly a dominant vegetation made by Typha, and gradually migration of trees occurred resulting in a forest vegetation dominated by Alnus, which eventually had undergone destruction to give way to plains dominated by such weeds as Chenopods, Plantago and the grasses.

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