MICROFLORA AND AGE OF PUNJAB SALINE SERIES FROM DHARIALA WELL NO. 1, SALT RANGE, WEST PAKISTAN

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Introduction

Phylogenetical history of vascular plants has been a problem of great interest to biologists from time immemorial and rocks of geologically earlier formations have been the subject of continuous attack for the find of a happy solution of the question. While Lang and Cookson's (1935) and Cookson's (1935) discovery of proto-lycopod *Baragwanathia* macrofossils from the Silurian of Victoria, Australia, may be much accredited, being the first definite record of the earliest existence of vascular plants on earth, it can by no means claim to be the final clue to the problem. For reports are now gradually accumulating from different parts of the world to prove beyond doubt the occurrence of vascular flora in such an early age as Cambrian. It was Darrah who, in 1937, first recovered pteridophytic and bryophytic plant spores in the Upper Cambrian of Kolm from eastern Sweden, but as the discovery was not consistent with the prevailing conception of plant phylogeny its value was underestimated. In India, Ghosh and Bose (1947) were the first to record remnants of vascular plants in the definitely known Cambrian beds of the Salt Pseudomorph Stage, in the Punjab Salt Range, and since then they have continued examining other Cambrian beds of India, Pakistan and abroad with the result that the existence of vascular plants in Cambrian times has become more and more evident (Ghosh and Bose, 1950*a*, 1950*b*, 1952*a*, 1952*b*, 1953, 1954).

In 1953, the author received from Messrs. Burmah Oil Co., Ltd. (through Shri A. K. Ghosh) six rock specimens from different depths of Attock Oil Co.'s Dhariala Well No. 1. These specimens were from cores of the Punjab Saline Series, the top of which occurred in the well at a depth of 1,470 feet. They are representative of the Upper Gypsum/Dolomite and Salt marl stages of that Series.

Description of Rock Specimens

The description of the rocks, as supplied by the Attock Oil Co., is given in the following table:—

Serial No.	Depth in Well, feet.	Description
1	1,550	Chocolate siltstone
2	1,960	Impure dolomite
3	1,987	Oil shale
4	2,350	Red marl
5	2,880	Rock salt with some inclusions of marl
6	3,965	Impure anhydrite

Technique

Samples 1 to 4 and 6 have been macerated in solutions of equal parts of nitric and hydrochloric acid with a little quantity of potassium chlorate in addition. On dissolution of the rocks, the clayey solutions have been washed in distilled water by the process of filtration in a Buchner funnel under reduced pressure. After proper washing, the residue on the filter bed has been bleached in 10% potassium hydroxide solution for 48 hours after which thorough washing has again been done by the process already mentioned. The residue has then been added with refiltered distilled water to have the solution spread on slides, dried, and examined.

Sample 5 has been dissolved in refiltered distilled water and the solution thus formed has been examined.

Needless to say every possible precautionary measure has been taken against laboratory contamination.

Observations

On examination samples 3 and 4 have yielded negative results and sample 5 has given only few fibrous structures.

Microfossils of the types of woods and spores have been recovered from samples 1, 2 and 6. Some of these microfossils are described here with a view to give an idea of the nature of plants of which they form fossilized parts, and an attempt has been made to show their distribution, with reference to spores only in the Cambrian and infra-Cambrian of various regions so far examined by the author.

A. Woods.

1. Scalariform tracheid—Several tracheids with scalariform pittings recovered from samples 1 and 2. Tracheids vary from 5·5 to 6·6μ in width; rungs or thickened borders are 3·3 to 6·6μ in breadth (Pl. XVI, Fig. 1).

2. Bordered pitted tracheid—Three tracheids with remnants of adjacent ones recovered from sample 6. Tracheids are 5·5 to 11μ in width; pits bordered, compact, arranged in a row or irregularly distributed, and elliptical; size 5·5$\mu \times$ 6·6μ; orifice 2·2$\mu \times$ 5·5μ; borders 1·5 to 2·2μ in breadth. Some of the bordered pits occasionally widen transversely to simulate a scalariform appearance (Pl. XVI, Fig. 2).

3. Bordered pitted tracheid—Several tracheids with remnants of adjacent ones recovered from sample 1. Tracheids are 4 to 6·5μ in width. Pits bordered, round, elliptical, compact, 1-rowed or irregularly distributed; orifice 2·2μ in dimension; borders 1·5μ thick (Pl. XVI, Fig. 3).

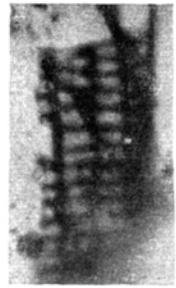
4. Bordered pitted tracheid—A fragment of a tracheid with three round pits recovered from sample 1. Orifice 4·4$\mu \times$ 5·5μ, pits crossing, 1·5$\mu \times$ 4·4μ; borders 2·2μ thick (Pl. XVI, Fig. 4). Also recorded in the Salt Pseudomorph Stage (G.S.I. 57/285) in the Punjab Salt Range, and in the mid-upper Cambrian of Kashmir (G.S.I. K.32/248).

5. Pitted wood—A piece of wood with apparently simple pits recovered from samples 1, 2 and 6. Pits appear simple probably due to heavy carbonization and are separate from one another, round and 3·3μ in dimension (Pl. XVI, Fig. 5).

B. Fibres.

A fibre, 907·5$\mu \times$ 12·1μ, semi-carbonized and brownish yellow in colour, recovered from sample 5. A portion of it only is shown in Pl. XVI, Fig. 6.

1



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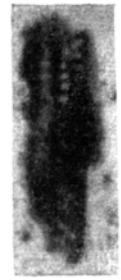

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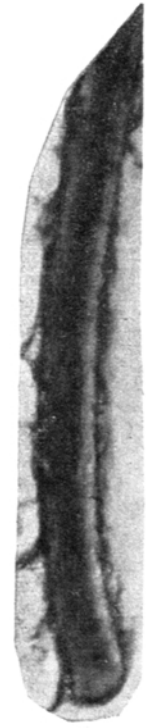

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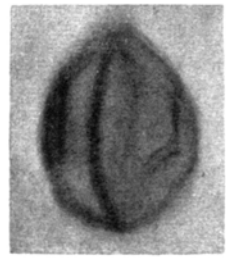

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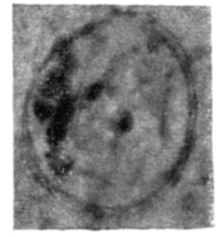

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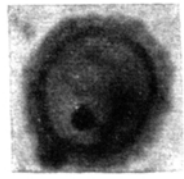

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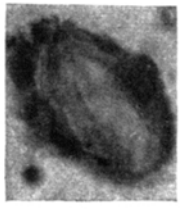

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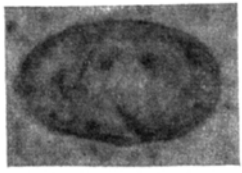

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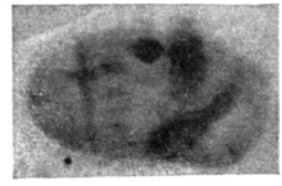

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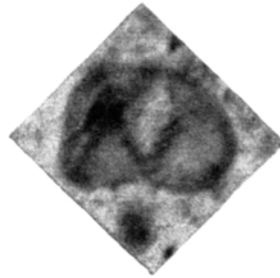

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C. Spores.

1. Psilate spore, elliptical, 14·3μ × 20·9μ; brownish yellow in colour, wall thin (Pl. XVI, Fig. 7).

Recovered from Dhariala sample 6; also from Kolhan Series (G.S.I. 6454).

2. A round spore 18·7μ in dimension, yellow in colour, wall 1μ thick, surface appears to be rough (Pl. XVI, Fig. 8).

Recovered from Dhariala sample 1; also from Upper Kaimur, Upper Vindhyans (G.S.I. 58/889), and Lower Kaimur, Upper Vindhyans (G.S.I. 58/895).

3. A round spiny spore with a short flange-like structure. The entire structure is 14·3μ × 15·4μ; brownish yellow in colour; spore body 13·2μ × 14·3μ, studded with very short spines; flange 1·2μ wide, wavy, formed probably by the projecting spines (Pl. XVI, Fig. 9).

Recovered from Dhariala sample 1; also from Braintree formation, *Paradoxides harlani* zone, mid Cambrians of N. America.

4. Elliptical monolete spore, psilate, golden yellow in colour, dimension 13·2μ × 17·6μ, slit of dehiscence elongate, tapering and 1·2μ × 13·2μ in size. Spore-wall 0·5μ thick (Pl. XVI, Fig. 10).

Recovered from Dhariala sample 2; also from Stephen formation, mid Cambrian of N. America, Upper Kaimur, Upper Vindhyans (G.S.I. 58/891), and Salt Pseudomorph Stage, Punjab Salt Range (G.S.I. 57/285).

5. Elliptical spore with an elongate slit of dehiscence, golden yellow in colour, dimensions 25·3μ × 39·6μ. Slit area 16·5μ × 39·6μ; wall very thin (Pl. XVI, Fig. 11).

Recovered from Dhariala sample 1.

6. One-winged spore 45·1μ across; yellow in colour; spore body roundish, dimensions 24·2μ × 27·5μ with a wide opening extending vertically, aperture 17·6μ × 22μ; wing densely reticulate 1μ × 11μ in size (Pl. XVI, Fig. 12).

Recovered from Dhariala sample 1; also from Salt Pseudomorph Stage, Punjab Salt Range (G.S.I. 57/285).

7. Two-winged spore 53·9μ across; spore body deltoid, 29·7μ (vertically) × 18·7μ (transversely, basal portion) to 39·6μ (transversely, apical portion) in size; golden yellow in colour; wings placed more or less symmetrically on two sides, reticulate, 14·3 to 20·9μ × 24·2 to 29·7μ in size (Pl. XVI, Fig. 13).

Recovered from Dhariala sample 2; also from Glauconite Beds, Semri Series (G.S.I. 58/911), and Salt Pseudomorph Stage, Punjab Salt Range (G.S.I. 57/285).

8. Two-winged spore 35·2μ across; spore body round, 22μ in dimension with 5 stripes traversing the body transversely reaching the wings for a considerable distance; golden yellow in colour; wings broadly reticulate, of the same colour as the spore body and 17·6μ × 30·8μ in size (Pl. XVI, Fig. 14).

Recovered from Dhariala sample 1; also from Glauconite Beds, Semri Series (G.S.I. 58/911), Fawn Limestones, Semri Series (G.S.I. 58/915), and Mandi Salt belt (G.S.I. 58/1032, and 58/1033).

Inference

Microfossils recovered from Dhariala Well No. 1 rock samples 1 and 2 are easily comparable to those so far recorded from rocks of undisputed Cambrian age of India, Pakistan and the U.S.A. and some of the microflora recorded in sample 6 resemble those obtained from the Eparchaean Kolhan Series.

In spite of geologists' (Christie, 1914; Fox, 1928, 1944; Gee, 1944, 1946, 1950; Pascoe, 1944; Stuart, 1919; Wynne, 1878) consistent advocacy for the Cambrian age of the Punjab Saline Series, palaeobotanists like Sahni (1944, 1946), Sitholey (1946), Lakhanpal (1946), Trivedi (1946), and others have regarded it as of Eocene or Tertiary age on the evidence of their microfossil data. The microflora so far recorded by them in different rocks of the Saline Series include various types of woods, cuticles of grass (?), cuticular structures, hairs, algal and insect remains, fungal spores,

spore-like bodies, spherical thin-walled or thick-walled spores 23·4μ to 26·4μ in dimensions, thin-walled or thick-walled ellipsoidal spores 13μ × 16·2μ in size, spherical monolete spores 13·6μ to 26μ in dimensions, and ellipsoidal monolete spores 18·2μ × 31·2μ in size. But it is interesting to note that similar microfossils and sometimes more advanced types of spores, e.g. trilete spores or winged spores or both, have been noted by the author in the Lower and Upper Vindhyans of India, and in the Cambrian of North America, the Punjab Salt Range and Kashmir. Even in the pre-Cambrian rocks, from the Kolhan Series (G.S.I. 6454), and the Gangpur Series (G.S.I. 5013), the author has recorded the occurrence of various types of carbonized woods, e.g. scalariform, apparently simple pitted, and simple types of spores (spherical or ellipsoidal, thin-walled or thick-walled) in abundance.

These results indicate that the included plant-fossils are of no value in support of Tertiary age for the Punjab Saline Series and that they are quite consistent with the Cambrian view.

Recently Singh (1952) has reported the occurrence of trilete spores (30μ to 41μ), tricolpate pollens and pollens with germ-pores in an oil shale from the Lower Gypsum Dolomite stage of the Saline Series in the Fatehpur Maira Gorge of the Punjab Salt Range. This discovery has led him to conclude that the Saline Series is of Tertiary age.

To multiply instances of Cambrian occurrence of trilete spores, reports of the investigation by Naumova (1949), Reissinger (1938, 1952, 1953), Kopeliovitch (1951), Jacob (1949), and Jacob *et al.* (1953*a*, 1953*b*) may be mentioned. Cases of discovery of angiospermic pollens in very early beds are also not at all unknown to-day. Reissinger (1952) reports the recovery of a Potamogeton pollen in the lower Cambrian dark blue clay Kunda in Esthonia; Radforth and McGregor (1954) report of their finding of a Nymphaeaceous pollen (Type G3′) in the Devonian rocks from the Wabamum Lake No. 1 well. In the Carboniferous rocks, Reissinger (1952, 1953) has recovered pollens of *Iris sibirica*, *Hydrocharis morsus*, *Nymphaea*, *Nuphar*, *Polygonum*, *Potamogeton*, *Limnanthemum* and pollens resembling those of *Quercus*, *Betula*, *Carya* and other palms. These data are sufficient to indicate that the existence of angiosperms is not always characteristic of the Mesozoic or Tertiary, but that they occur also in rocks of Cambrian, of Devonian and of Carboniferous ages.

In conclusion, it may be said that since the rocks of the Dhariala well contain a microflora similar to that recovered from the undisputed Cambrian formations of the Punjab Salt Range, from the Vindhyans of India and the Cambrian of Kashmir and North America, they are considered to be Cambrian in age. The Punjab Saline Series of other localities in the Salt Range also entombs microfossils most of which are identical with those found in undisputed Cambrian rocks.

Acknowledgement

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Abstract

Six rock-specimens from Cores taken from the Punjab Saline Series, Dhariala Well No. 1, have been examined. The microflora recovered resemble those recorded from undisputed Cambrian rocks. The age of the rocks analysed is, therefore, considered to be Cambrian.

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Explanation of Plate XVI

(All the photographs are untouched)

Fig. 1. Scalariform tracheid. ×450.
„ 2. Bordered pitted tracheid. ×450.
„ 3. Bordered pitted tracheid. ×450.
„ 4. Bordered pitted tracheid. ×1,000.
„ 5. Apparently simple pitted wood. ×450.
„ 6. A portion of a long fibre. ×450.
„ 7. Spore. ×1,000.
„ 8. Spore with rough surface. ×450.
„ 9. Spiny spore with a short flange. ×450.
„ 10. Monolete spore. ×450.
„ 11. Monolete spore. ×450.
„ 12. One-winged spore. ×450.
„ 13. Two-winged spore. ×450.
„ 14. Two-winged spore with stripes. ×450.

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