CHAPTER - 7

PALAEOFLORAL REMNANTS OF THE
SINGRIMARI SEDIMENTARY COLUMN

7.1 INTRODUCTION

Historically all the branches of Palaeobotany, after the initial spurt by Oldham and Morris (1863) Feistmantel (1886) and others, got a fresh beginning under the inspiring guidance of Prof Birbal Sahni (1921) and his teacher Sir Albert Seward (1920). Such was possible because of the Gondwanic hosts. Several successive levels of flora are known from the Gondwanas, sometimes this knowledge has been used to classify the Gondwanas into three divisions, viz: Lower (Glossopteris Flora), Middle (Dicroidium Flora) and Upper (Ptilophyllum Flora). Originally only two subdivisions, i.e., Lower and Upper were recognised, (Feistmantel, 1876). The findings of a transitional flora at Parsora in South Rewa led to the recognition of the Middle Subdivision (Vredenburg, 1910, Wadia, 1926, Lele, 1964). However, as pointed by Sahni (1963) neither of the classifications is tenable.

In context with the present chapter, the aforesaid paragraph suits as an introduction by virtue of the presence of certain key plant fossils (mega) like Glossopteris, Vertebra etc. In the same vein, it may also be stated that an investigation of palaeofloral remnants within the Singrimari Sedimentary Column was carried out in two lines - plant fossils (mega) and palynology (spores and pollens). Following this is a description of the findings which is scarce both in variety and quantity.

7.2A PLANT FOSSILS (MEGA)

Plant fossil finds are restricted to the carbonaceous shale unit due to absence of any other appropriate host rocks. Both leaf and stem parts have been discovered. But, it is seen that the leafy impressions are ill-preserved. This has got an influence of the displacements and slippages (Pl.- 7.1) in the host rock which aggravated the surficial leafy imprints.

7.2A.1 Glossopteris

The name Glossopteris was proposed by Brongniart (1922) but, Siernburg (1825), gave it a generic status. In 1828, Brongniart published a diagnosis of the type species, G browni
from Australia and India. The Indian forms were described as *G. browniana var. indica* and the Australian forms as *G. browniana var. australiasica*. Brogniart defined *Glossopteris* as "fronds simple, lanceolate with a prominent midrib, secondary veins reticulate only at the point of origin near the midrib". Schimper, (1869) changed the 'indica' variety of Brongniart into a species, *G. indica*. Burnbury (1861) was one of the oldest authors on *Glossopteris* species and he established three *G. stricta*, *G. musaefolia* and, *G. leptoneura*. Feismantel discovered twelve such species and as on today over hundred species of *Glossopteris* have been established based on morphography, cuticular studies etc., (Banerjee, 1971).

Indian *Glossopteris* species can be grouped conventionally into three categories - narrow meshed forms, broad meshed forms and intermediate forms. (Chandra, 1976)

I. Division : *Phanerogams*
   Sub-division : *Gymnospermae*
   Group : *Pteridospermae*
   Description : Leaf lanceolate, midrib prominent, secondary veins very faint form oblong polygonal meshes which become somewhat narrower towards the margin, anastomosing throughout the lamina. An intermediate form.
   Genus : *Glossopteris*
   Species : *browniana*
   Age : Permo-Carboniferous
   Figure : *Plate 7.2*

II. Division : *Phanerogams*
   Sub-division : *Gymnospermae*
   Group : *Pteridospermae*
   Description : Leaf narrow, strap shaped, midrib visible, secondary veins numerous, straight, close and perpendicular near the margin and anastomosing near the midrib. A narrow form.
   Genus : *Glossopteris*
   Species : *stricta*
   Age : Permo-Carboniferous
   Figure : *Plate 7.3*
7.2A.2 Vertebraria

"The true original Vertebrariae, a stem of *Glossopteris*, according to McCoy, owe their singular form to densely compacted whorls of surrounding leaves without interruption", *Bumbury (1861)*

<table>
<thead>
<tr>
<th>Division</th>
<th>Phanerogams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-division</td>
<td>Gymnospermae</td>
</tr>
<tr>
<td>Group</td>
<td>Pteridospermae</td>
</tr>
<tr>
<td>Description</td>
<td>Sample divided longitudinally by a median groove into two halves each of which is transversely segmented into rectangular area. The rectangular areas are alternate on two sides of the median groove and each areas have a transverse ridge at the middle.</td>
</tr>
<tr>
<td>Genus</td>
<td>Vertebraria</td>
</tr>
<tr>
<td>Species</td>
<td>indica</td>
</tr>
<tr>
<td>Age</td>
<td>Permo-Carboniferous</td>
</tr>
<tr>
<td>Figure</td>
<td>Plate 7.4</td>
</tr>
</tbody>
</table>

7.2A.3 Calamites

The name *Calamites* was originally used for the pith casts in 1784 by Suckow, who was one of the first to suspect the true status of this fossil. Earlier to that, it was believed to be giant grasses or bamboos, *(Arnold, 1947)*.

<table>
<thead>
<tr>
<th>Division</th>
<th>Cryptogams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-division</td>
<td>Sphenopsida</td>
</tr>
<tr>
<td>Group</td>
<td>Calamitales</td>
</tr>
<tr>
<td>Description</td>
<td>Stem consists of vascular bundles, nodes and internodes, internodal area prominent and shows a serrated continuation along the nodes longitudinal striations along the length of the internodal area seen</td>
</tr>
<tr>
<td>Genus</td>
<td>Calamites</td>
</tr>
<tr>
<td>Species</td>
<td>cistii</td>
</tr>
<tr>
<td>Age</td>
<td>Permo-Carboniferous</td>
</tr>
<tr>
<td>Figure</td>
<td>Plate 7.5</td>
</tr>
</tbody>
</table>

7.2A.4 Schizoneura

"*Schizoneura* is an *Equisetalean* genera of which rather little is known. The jointed longitudinally
furrowed stems bear leaf sheaths at each node that are split into two large multi-nerved segments on opposite sides of the stem.**, (Arnold, 1947).

Division: Cryptogams
Sub-division: Sphenopsida
Group: Equisetales
Description: Stem narrow with internodal area only, internodal area prominent with narrow longitudinal ribs along the length.
Genus: Schizoneura
Species: gondwanensis
Age: Permo-Carboniferous
Figure: Plate 7.6

7.2B PALYNOLOGY

7.2B.1 Introduction

The science of palynology as presently understood includes the study of spores, pollens, phytoplanktons and other microscopic organic matter including the animal remains such as micro-foraminiferal linings, chitinozoa and scolecodonts.

The present venture seeks to enlist the palynomorphs encountered scarcely while studying each lithounits of the Singrimari Sedimentary Column. But prior to that, a brief note on the attributes and significance of spores and pollen grains are spelt out here.

7.2B.2 Palynomorphs

The term spore refers to any single-celled or few-celled body, produced as a means of propagating a new individual. Pollens on the other hand are an advanced entity (male counterparts of flowering plants - gymnosperms and angiosperms) of the same, (Braisser, 1993).

Palynomorphs are found in abundance in a variety of rocks ranging from Precambrian to Recent, (Tschudy and Scott, 1969) although, they have not received the general acceptance. However, characteristics of spores and pollens not only throw much light into the evolutionary history of the plant kingdom but also substantiate geologic histories, (Nair, 1968).

It is the extra-ordinary resistant spore-pollen wall or exine material, 'sporopollenin' that
facilitates their preservation and survival as fossils in sediments. They even escape the destructive action of drilling bits. Seemingly unfossiliferous rocks too yield palynofossils and, their enormous production facilitates recovery of statistically significant assemblages.

It is their immensely small size that played/plays a significant role in their dispersal - primarily by wind. They thus, get transported and deposited into continental, lacustrine, lagoonal, littoral and neritic environments.

Besides being put to used for age determination, correlation and palaeo-environmental interpretations, palynological assemblages can be used for deducing palaeo-shore lines. Terrestrial and phytoplankton ratios are used to determine ancient shore line. There is generally an increase of terrestrial palynofossils and organic matter towards land and marine components towards sea.

7.2B.3 Extraction techniques

The method for the recovery of palynofossils involve the use of acids like HNO₃-HCl-HF on the sediments. While HNO₃ acts on the organic matter, HCl and HF destroys calcareous and siliceous matters respectively. The sediments after being digested by acids are treated with 5%-10% KOH solution for 5-10 minutes. The macerate comprising the organic residue is washed and floated in a ‘heavy liquid’ (mixture of iodes of potassium, cadmium and zinc) of sp gr 2.3. The slides are prepared from the lighter fraction of the residue using polyvinyl alcohol and canada balsam, (Gray - 530-587, in Kummel and Raup,1965)

The slides for the study of the total dispersed organic matter are prepared from unoxidised macerate (HNO₃ is not used).

7.2B.4 The Spores And Pollens

In the systematic study of spores and pollen grains, the basic approach is morphological. The basis of similarity in various characters of the individuals need to be critically examined to specify them into particular species and genera. It is therefore necessary firstly, to rationally differentiate between the morphological characters and thereafter assess taxonomic values of the spores. Naturally, this requires a detailed study of a very large number of well preserved specimens. Only after this, a proper morphological systemisation is possible. In the systematic study of spores and pollen grains, the morphological characters like shape, ornamentation.
size ratio of the body to sacci etc. are the essential factors to be considered. The system of classification of spores and pollens by Potonié and Kremp, 1954, 1955, 1956, (in Braisser, 1993, Singh and Shah, 1971) is one of the best possible classifications. Taxonomic classifications in this regard are based on the word ‘Turma’. Sporites are included in the category ‘Anteturma Sporites’ and pollens in ‘Anteturma Pollenites’. Below this rank, there is a descending hierarchy of taxa as Turma, Subturma, Infraturma and so on each based on rigid morphological criteria.

In the present venture, representative samples from each of the lithounits of the Singrimari Sedimentary Column were put to thorough investigation in search of spores and pollen grains which however proved to be redundant as only ten diagnostic forms could be seen. A description of the same follows.

I. Anteturma : *Pollenites* (Potonié, 1931)

Turma : *Polyplicates* (Erdtm an, 1952)

Genus : *Gnetaceae pollenites* (Thiergat, 1938)

Description : Fusiform micropore with distinct folds extending full length of the grain. The folds are almost parallel but converge at one end and diverge at the other, exine laevigate.

Found in : Basal Sandstone

Figure : Plate 7.7

Compared from : Agashe and Chitnis, 1971 (plate 1; figure 13)

Taxonomy : cf. Singh and Shah, 1971

II. Anteturma : *Pollenites* (Potonié, 1931)

Turma : *Saccites* (Erdtm an, 1947)

Subturma : *Disaccites* (Cookson, 1947)

Infraturma : *Striatiti* (Pant - Bharadwaj, 1962)

Genus : *Verticipollenites* (Bharadwaj, 1962)

Description : Pollen grain disaccate, central body oval, horizontal sacci - egg shaped with a wide neck, sulcus straight, exine laevigate

Found in : Basal Sandstone

Figure : Plate 7.8

Compared from : (a) Agashe and Chitnis, 1971 (plate 2; figure 29)

(b) Mukherjee and Ghosh, 1971 (plate 3; figure 21)

Taxonomy : cf. Singh and Shah, 1971
III. Anteturma: *Sporites* (Potonié, 1893)
Turma: *Zonales* (Potonié, 1956)
Subturma: *Zonotriletes* (Waltz, 1935)
Infraturma: *Cingulati* (Potonié and Kremp, 1954)
Genus: *Dentatispora* (Tiwari, 1964)
Description: Spore circular, trilete mark faint to indistinct, exine spinose
Found in: Upper Sandstone
Figure: Plate 7.9
Compared from: Mukherjee and Ghosh, 1971 (plate; figure 12)
Taxonomy: cf. Singh and Shah, 1971

IV. Anteturma: *Pollenites* (Potonié, 1931)
Turma: *Saccites* (Erdtman, 1947)
Subturma: *Disaccites* (Cookson, 1947)
Infraturma: *Disaccimonoleti* (Klaus, 1963)
Genus: *Alisporites* (Nilson, 1958)
Description: Grain oval, Central body not well defined, exine granulate, sacculus prominent.
Found in: Carbonaceous Shale
Figure: Plate 7.10 (1)
Compared from: Tripathy, 1989 (BSIP Slide No. 9590)
Taxonomy: cf. Singh and Shah, 1971

V. Anteturma: *Pollenites* (Potonié, 1931)
Turma: *Monocolpate* (Iverson and Troels-Smith, 1950)
Genus: *Marsupipollenites* (Balme and Hennelly, 1956)
Description: Grain subcircular, exine laevigate, sulcate marks prominent along circumference.
Found in: Upper Sandstone
Figure: Plate 7.10 (2)
Compared from: Tripathy, 1989 (BSIP Slide No. 9591)
Taxonomy: cf. Singh and Shah, 1971

VI. Anteturma: *Sporites* (Potonié, 1893)
Turma: *Triletes* (Potonié and Kremp, 1954)
Infraturma : \textit{Apiculati} (Potonié, 1956)

Genus : \textit{Cyclogranisporites} (Potonié and Kremp, 1954)

Description : Spore sub-subcircular, trilete mark faintly visible, one arm shorter than the others, exine finely granulate - evenly disposed.

Found in : Upper Sandstone

Figure : Plate 7.11

Compared from : Mukherjee and Ghosh, 1971 (plate 2,3; figure 5,8)

Taxonomy : cf. Singh and Shah, 1971

VII. Anteturma :

Turma : \textit{Pollenites} (Potonié, 1931)

Subturma : \textit{Saccites} (Erdtman, 1947)

Infraturma : \textit{Monosaccites} (Potonié and Kremp, 1954)

Genus : \textit{Triletisacciti} (Leschuk, 1955)

Description : Monosaccate pollen grain, oval shaped, two arms of trilete mark distinct, exine granulose.

Found in : Basal Sandstone

Figure : Plate 7.12

Compared from : Tripathy, 1989 (BSIP Slide No. 9593)

Taxonomy : cf. Singh and Shah, 1971

VIII. Anteturma :

Turma : \textit{Sporites} (Potonié, 1893)

Subturma : \textit{Azonomonoletes} (Ibrahim, 1933)

Infraturma : \textit{Laevigatomoleti}

Genus : \textit{Latosporites} (Potonié and Kremp, 1954)

Description : Spore sub-subcircular, monolet mark distinct - almost extended up to periphery, exine thick, laevigate.

Found in : Basal Sandstone

Figure : Plate 7.13

Compared from : Mukherjee and Ghosh, 1971 (plate 3; figure 14)

Taxonomy : cf. Singh and Shah, 1971

IX. Anteturma : \textit{Pollenites} (Potonié, 1931)

Turma : \textit{Saccites} (Erdtman, 1947)
Subturma: **Monosaccites** (Potonié and Kremp, 1954)

Infraturma: **Parasaccites** (Maheswari, 1967)

Genus: **Parasaccites** (Bharadwaj and Tiwari, 1964)

Description: Monosaccate pollen grain with sub-circular outline, exine finely inter-reticulate, trilete mark indistinct.

Found in: Upper Sandstone

Figure: Plate 7.14

Compared from:
- (a) **Mukherjee and Ghosh, 1971** (plate 3; figure 18)
- (b) **Venkatagala, 1978** (plate 1; figure 20)

Taxonomy: cf. Singh and Shah, 1971

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X. **Anteturma**: **Sporites** (Potonié, 1893)

Turma: **Triletes** (Potonié and Kremp, 1954)

Infraturma: **Apiculati** (Potonié, 1956)

Genus: **Lophotriletes** (Potonié and Kremp, 1954)

Description: Spore sub-subcircular, trilete mark extended up to periphery, exine thick, laevigate.

Found in: Siltstone

Figure: Plate 7.15

Compared from: **Mukherjee and Ghosh, 1971** (plate 3; figure 7a, 7b)

Taxonomy: cf. Singh and Shah, 1971

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### 7.2.B.5 Age And Correlation

Enlisted below is a list of published findings of some miospores from the viewpoint of age and host Gondwana Formations by some workers having similarity with those from Singrimari.
7.3 DISCUSSION

Palaeofloral remnants in the Singrimari Sedimentary Column are scarce, a surprising find considering the characteristics of the lithounits.

Plant fossils (mega) are very limited in variety and quantity with they being restricted only to the carbonaceous shale. These characteristic Permo-Carboniferous Gondwanan entities appear in both leaf and stem forms with the latter being more prominent due to their resistance. Singrimari miospores contain both pteridophytic spores and gymnospermous pollen grains. Miospores distribution is scarce and erratic. Their variations substantiate the fact that petrologic variations may be sharp while palynological variations are mostly gradational. (Ghosh 1971). Thus, the different lithounits of Singrimari cannot be differentiated on miospore distribution. It would be rather appropriate to class the Singrimari Sedimentary Column as an entity of the Permo-Carboniferous Period and, a part of the Lower Gondwanas.

Examination of all thin-sections show (apart from spores and pollen grains), organic matter types like resinites, cuticles, biodegraded terrestrial organic matter, charcoal. (Pl.-7.16), finely divided organic matter and fungal spores. The palynofacies is found to be humic-terrestrial. Charcoal and woody parts indicate the kerogen type as Type III while spores and cuticles hint about Type II kerogen.

It is also seen that in this scarcely populated Column (from the view point of spores and pollen grains) total organic content variation is catchy. Baring the carbonaceous shale layer in which total organic content is very high (see 6.7), it is lower in case of the other units. Moreover, dominance of brown to black organic matter is an indication of a high temperature induced phenomenon. However, it is difficult to precisely ascertain the factors behind this temperature effect. It could be due to the baking effect of the dolerite intrusions resulting in sporadic Jhama like transformation of the shaly layer in patches. Tectonic plays might also have been a contributor in this regard and, westward slippages in the shaly layers may be manifestation of this. Such features are restricted to the carbonaceous shale layer due to the nature of their physical composition. It may be noted that such lithounits enhance displacements in a large scale as a manifestation of this may be considered the Belt of Schuppen of the Assam-Arakan Basin (cf., GSI. 1985, p.10). Such dynamisms can very well lead to temperature induction and moreover, such a phenomenon will easily disfigure many palaeofloral remnants even if they were present.
Rarity of fossillic remnants could be due to a braided (strong and wandering) environmental setup for the lower part of the sedimentary column (cf., Pettijohn et al., 1973). However, virtual scarcity of plant fossils (mega) and absence of miospores in a host like carbonaceous shale needs an explanation. Only one genera - *Alisporites* has been recovered from this unit. Factors like the small thickness of this unit (a measure of the spatial and temporal dimensions), presence of pyritic specks, fluctuations in the oxidation state (see 6.8), overall dynamism of the depositional setup (see 8.4), could have in some or the other way contributed to such a condition. Post-depositional tectonic plays further aggravated the situation. Further, absence of suitable host rocks in the upper part of the column may be cited as a responsible factor. However, this rarity is a reality which could at best be considered as an axiom.
Plate 7.1: Photograph showing slip planes in carbonaceous shale directed towards west.

Plate 7.2: Photograph showing a specimen of *Glossopteris browniana*. Pressure and slip effects have distorted the fine impressions where now, only the mid-rib is distinct.
Plate 7.3: Photograph showing a specimen of *Glossopteris stricta*. Pressure and slip effects have distorted the fine impressions where now, only some veins are seen.

Plate 7.4: Photograph showing a specimen of *Vertebraria indica*. 
Plate 7.5: Photograph showing a specimen of *Calamites cistii*.

Plate 7.6: Photograph showing a specimen of *Schizoneura gondwanensis*.
Plate 7.7: Photomicrograph showing a genera of *Gnetaceaeopollenites*, (1000X).

Plate 7.8: Photomicrograph showing a genera of *Verticipollenites*, (400X).
Plate 7.9: Photomicrograph showing a genera of *Dentatispora*, (1000X).

Plate 7.10: Photomicrograph showing genera of *Alisporites* (1) and *Marsupipollenites* (2), (500X).
Plate 7.11: Photomicrograph showing a genera of Cyclogranisporites, (1000X).

Plate 7.12: Photomicrograph showing a genera of Divarisaccus, (1000X).
Plate 7.13: Photomicrograph showing a genera of *Latosporites*, (1000X).

Plate 7.14: Photomicrograph showing a genera of *Parasaccites*, (1000X).
Plate 7.15: Photomicrograph showing a genera of *Lophotrites*, (1000X).

Plate 7.16: Photomicrograph showing degraded amorphous organic matter, wood and charcoal in carbonaceous shale, (250X).