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RECENT PALAEOBOTANICAL ADVANCES IN
THE STUDY OF GONDWANAS IN INDIA

BY

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Director-General, Geological Survey of India, Calcutta



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YOUR EXCELLENCY, DR. KOTHARI, MADAM PRESIDENT, LADIES AND GENTLEMEN,

I WISH to express my sincere thanks for the great honour you have done me in inviting me to deliver the Eleventh Sir Albert Charles Seward Memorial Lecture under the auspices of Birbal Sahni Institute of Palaeobotany. Today we have gathered here to celebrate the birthday of the Doyen of Indian Palaeobotany, the late Professor Birbal Sahni, the founder of this great Institute. In the past, several eminent persons have addressed on this occasion. I am fully conscious of my limitations and I may be pardoned if my address fails to reach the standards set by my predecessors, but, nevertheless, those who gave me this responsibility should be equally blamed.

An attempt has been made in my address to present some recent palaeobotanical advances in the study of the Indian Gondwanas. In this connection, reviews of palaeobotanical studies have been made from time to time, the most important being by the late Professor Birbal Sahni (1922 and 1938).

In dealing with a subject like the Gondwanas or the stratigraphic problems concerning it, it is essential that all the aspects of palaeontology are given equal importance. Hence you would pardon me if I have included some significant palaeontological work in addition to that of palaeobotany to which I have given prominence in my address.

The general sequence of the Gondwana formations is shown in the accompanying table. The Gondwana deposits which are mostly of fluvial and lacustrine in nature with a few marine intercalations, range in age from Upper Carboniferous to perhaps Middle Cretaceous. Gondwanas are developed chiefly in the peninsular India at Damodar Valley, Son-Mahanadi Valley,

Satpura region and Godavari Valley. Small outliers are also found on the east as well as west coasts. All along the Himalayan ranges scattered occurrences of Gondwana rocks are also known to occur.

In the recent years many records of fossil plants, invertebrates and vertebrates have been made and several new fossiliferous localities been reported, which are highly significant in the geology of the Gondwanas.

Classification: The opinions differ regarding the classification of the Gondwanas. Some authors feel that the Gondwanas may be divided into lower, middle and upper, while others favour only lower and upper divisions. Some also correlate the various stages of the Gondwanas with the Standard Stratigraphical Scale. Fox (1931) after reviewing all the evidences, favoured a twofold classification which is being generally followed. This was supported on the evidence of vertebrate remains (AIYENGAR & VENKATARAM, 1940). It was Feistmantel (1882) who suggested a tripartite division of the Gondwanas on the floral evidences. The recent palaeobotanical work (SAKSENA, 1952; LELE, 1962a, b) also suggests a tripartite division of the Gondwanas.

LOWER GONDWANAS

Glossopteris Flora: The Lower Gondwana flora is generally termed as Glossopteris flora, as *Glossopteris* is the most predominant fossil plant in the assemblage. The recent record of *Glossopteris* from Upper Gondwana members by Nageswara Rao & Shah (1960a) has become significant and the term Glossopteris flora is gradually losing its much-attached significance. On the other hand,

Gangamopteris is restricted wholly to Lower Gondwanas. The fact that eight species of *Gangamopteris* and only four species of *Glossopteris* occur in Talchirs has influenced Ahmad & Ahmad (1962) to name the Lower Permian flora as *Gangamopteris* flora and Middle and Upper Permian flora as *Glossopteris* flora. Thus there is a growing tendency amongst the present workers to term a part of the flora of the Lower Gondwanas as *Gangamopteris* flora.

In the study of the *Glossopteris* flora Plumstead's (1952) contributions to the fructifications of this genus have considerably added to our knowledge regarding its affinities. Sen (1955) has described some male fructifications referable to *Glossopteris* while Verma (1963) has recorded some female fructifications from Chintalpudi sandstones of Andhra Pradesh.

Study of ovulate fructification borne on the midrib of *Glossopteris* leaves shows that *Glossopteris* may be split into a number of genera as suggested also by cuticular study (SURANGE & SRIVASTAVA, 1957). A new seed *Stercocarpus emarginatus* gen. et sp. nov. and a male fructification bearing monolete spores from Raniganj series are recent finds in the Lower Gondwana strata (SURANGE, 1957).

The detailed work on fructification will go a long way in the systematic placing of the genus *Glossopteris*.

Thomas (1952) pointed out that most probably *Glossopteris* and *Vertebraria* are not parts of the same plant. However, Surange & Maheshwari (1962) have studied the genus *Vertebraria* in detail and are of the opinion that *Vertebraria*, beyond doubt, is the rhizome of *Glossopteris*.

Tongue-shaped leaves found in the *Glossopteris* flora include, besides *Glossopteris* and *Gangamopteris*, the three other forms, *Noeggerathiopsis*, *Palaeovittaria* and *Taeniopteris*. Some of these *Taeniopteris* leaves have been assigned to a new genus *Rhabdotaenia*. The detailed epidermal studies

of this genus from a number of leaf fragments collected from Raniganj coalfield, as described by Pant and Verma (1963), have enabled specific differentiation of the genus.

Spiroxylon indicum Mehta (1952) is the first record of Taxinean wood from the Lower Gondwanas of India.

Talchirs: The geological age of the Talchir series has a great significance in the Indian stratigraphy. The recent reports of the marine fauna, at Manendragarh in Madhya Pradesh by Ghosh (1954) and Badhaura in Rajasthan by Misra, Srivastava and Jain (1961), from the lower and upper members of the Talchirs (SHAH, 1963) and the study of the Umaria marine bed (DICKINS & THOMAS, 1959) suggest that the major portion of the Talchirs deposited during the Lower Permian times and not wholly during the Upper Carboniferous period as known earlier. The study of the marine fauna also suggests important palaeogeographical conditions of that period.

Another aspect of the Talchir series is its flora. Many new additions have been made to this assemblage. Surange & Lele (1956) have reported *Gangamopteris cyclopteroides*, *Noeggerathiopsis hislopi*, etc., from a new fossiliferous locality from Giridih coalfield. Another interesting report is of *Paranoeladus* from South Rewa Gondwana basin by the same authors (1957). This completes the list of all the three known Carboniferous and Permian conifers of the southern continents.

Panchets: The reported occurrence of the reptile, *Lystrosaurus* in the Panchets of Raniganj coalfield by Tripathi and Satsangi (1961) is of great significance. This indicates that Panchets are definitely of Lower Trias in age.

UPPER GONDWANAS

Tiki-Parsoras: The age of the Parsoras has been much debated and it has been referred to differently as Lower Trias (even late Permian), Rhaetic and slightly older than Jurassic. Its study has evinced much

TABLE SHOWING GONDWANA FORMATIONS

		GONDWANA DIVISIONS	DAMODAR VALLEY	SON-MAHANADI VALLEY	SATPURA REGION	GODAVARI VALLEY	EAST COAST	STANDARD SCALE
UPPER GONDWANA	JABALPUR	Uma	—					Middle Cretaceous Lower Cretaceous
		Jabalpur	—	Bansa Beds	Jabalpur	Chikiala	Tirupathi-Pavalpur-Satyavedu	Upper Jurassic
		Kota	—		Chaugan	Kota	Raghavapuram-Vemavaram-Sriperumbudur	Middle Jurassic
	RAJMAHAL	Rajmahal	Rajmahal	Athgarh Sandstone				
		—	Dubrajpur	? Parsora			Gollapili-Budavada	Lower Jurassic
	MAHADEVA	Maleri		Tiki	Bagra Denwa	Maleri		Rhaetic Keuper
Pachmarhi		Supra Panchet		Pachmarhi			Muschelkalk	
—								
LOWER GONDWANA	DAMUDA	Panchet	Panchet	—	Almod	Mangli		Bunter
		Raniganj	Raniganj	Himgir-Pali	Bijori	Kamthi Chintalpudi	Chintalpudi sandstone	Upper Permian
		Barren Measures	Barren Measures	—	Motur	—		Middle Permian
	BARAKAR	Barakar	Barakar					
		Karharbari	Karharbari	Barakar	Barakar	Barakar		Lower Permian
	TALCHIR	Rikba	Talchir	Talchir	Talchir	Talchir		
Talchir								
Tillite		Tillite	Tillite	Tillite	Tillite		Upper Carboniferous	

interest in the classification of the Indian Gondwanas.

Fox (1931) restricts the name Parsoras to the beds around Parsora village which in his opinion are Rhaetic in age.

Saksena (1952) who examined the plant fossils from Daigaon and Parsora, classified the beds of the area into two divisions, one with purely a Lower Gondwana flora and the other with a mixed flora. He places the latter with the Middle Gondwanas and regards it as a convenient division.

Sahni & Tewari (1958) for the first time gave an account of Tiki and Maleri Unionids and described four species of the new genus *Tihkia*.

Sahni & Nageswara Rao (1956) have opined that Tiki beds are older than the Parsoras and the former are Middle Trias in age while the latter may range from Keuper to Rhaetic.

Lele (1962a & b) differentiates *Dicroidium* from *Thinnfeldia* and describes a rich assemblage of plant fossils from the Parsora beds emphasizing that this assemblage is the Indian representative of the general *Dicroidium* flora which flourished during Triasso-Rhaetic times on the southern continents.

Rajmahals Among the Gondwanas, the Rajmahal flora is a classic one which has been intensively studied and a number of papers published in recent years. In this connection the work of Birbal Sahni Institute of Palaeobotany is important. Special mention may be made of Vishnu-Mittre, Bose, Bharadwaj, Sah and others who have contributed much to the knowledge of the Rajmahal flora. Some important contributions have also been made by the Geological Survey of India.

Pentoxylon sahnii and *Carnoconites* have been shown to be related to *Taeniopteris spatulata*. The three have been grouped into a new gymnospermous group Pentoxyleae, believed to be the most primitive among cycadophytes (SAHNI, 1948).

Vishnu-Mittre (1959) after a detailed study of the important plant groups from Nipania

has come to the conclusion that the Nipania flora is comparable to that of the Jabalpur and Kota stages and thus believes it to be the uppermost horizon in the Rajmahal stage.

Adyalkar & Nageswara Rao (1960) after the study of plant fossils from Athgarh sandstone confirm that they are equivalents of Rajmahal stage. Gopal, Jacob & Jacob (1957) discuss the stratigraphy and palaeontology of Ramnad district on the east coast. This locality is 150 km south of the hitherto known Gondwana patch of peninsular India and is recorded for the first time.

Nageswara Rao & Shah (1960a) have studied the Kota-Maleris of Andhra Pradesh and Maharashtra and on the basis of the flora and fauna, they opine that the lower horizons may be of Upper Triassic, whereas the upper horizons might range up to Jurassic. They (1959) also have reported a richly fossiliferous band of Kota limestone containing fossil insects belonging to the Orders Blattoidea, Coleoptera and Hemiptera and also record the occurrence of *Pterosaur*, a flying reptile, from these beds of Chanda district, Maharashtra.

Jabalpurs. In recent years some valuable contributions on the Jabalpur flora have been made which have helped in fixing the age of the series. However, it still remains a controversial problem. In this direction special mention should be made of Bose & Sukh Dev (1959) who report the occurrence of two characteristic Wealden Ferns from Bansa and Sehora. In the light of this record they support a Lower Cretaceous age to the Jabalpur series.

Recently, Agrawal (1963) on the basis of the plant fossils studied by him from the type area of Jabalpur, proposes to drop the earlier view of the division of Jabalpur series into two stages.

Nageswara Rao & Shah (1960b) record for the first time plant fossils from the Chikiala beds and confirm that they are equivalent to Jabalpurs.

Bhuj beds: Recently, Verma & Rawat (1963) have studied plant fossils, mainly pollen and spores from Dhrangadhra beds, and on the basis of their study, the possibility of a Lower Cretaceous age has been indicated. However, according to Krishnan (1956), the lower half of Dhrangadhra formations is of Jabalpur age while the upper half represents Umia age.

According to Rajnath (1952), on the basis of associated marine fossils, the age of the plant beds has been assigned a post-Aptian, probable, Middle Cretaceous age. It is of great importance as it throws light on the upper age limit of the Gondwana group as a whole.

PALYNOLOGICAL STUDIES

Palynological studies of coal and associated sediments are of great economic importance as they help in the correlation and exploration of coal seams. Recently a number of investigations have been carried out on the Lower Gondwana sediments and the results have been published from time to time. On the basis of palynological study, Ghosh & Sen (1948) have successfully attempted to correlate the Satpukuria, Ghusick and certain other associated seams in Raniganj coalfield. Shrivastava & Pawde (1962) have been able to demarcate the boundary between Raniganj and Panchet beds near Ondal, West Bengal, hitherto undifferentiated on lithological grounds.

A number of palynological investigations are also being carried out by the Geological Survey of India on the Gondwana coals and associated strata of various coalfields. In this aspect, the work of the Birbal Sahni Institute of Palaeobotany and others are worth mentioning.

An interesting study has been made by Bharadwaj (1962) of microspore elements in coal seams of eastern Raniganj coalfield with a view to ascertaining the validity of stratigraphic zoning with spores and seam identification. A large number of spore types have been described.

Successful correlation of the Gondwana system calls for sustained work on the microflora and detailed field mapping.

CONCLUSION

In conclusion, it may be pointed out that there are several unsolved problems in the proper understanding of the Gondwanas. The following are some of the palaeontological aspects which require immediate attention:

1. Intensive search and study of the marine intercalations in the Gondwanas.
2. Detailed study of the flora of the Talchirs, Karharbaris, Gondwanas of Satpura basin and the coastal Gondwanas; and
3. Preparation of standard section of the Gondwanas of India on the basis of palynological studies.

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