Provincialism in Gondwana floras

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The Gondwana sediments of India, ranging from Asselian to Rhaetian in age, contain remnants of a unique flora that in general composition is uniform all over. Two basic floral assemblages, i.e., *Glossopteris*-Assemblage and *Dicroidium*-Assemblage, can be recognized through Permian and Triassic, respectively. A synthesis of data on distribution of plant fossils in different formations of the Gondwana Supergroup brings out an incipient provincialism throughout, particularly in the Barakar Formation. It is not yet understood if this provincialism is apparent or real.

Key-words—Gondwana Supergroup, Glossopteris Flora, Dicroidium Flora, Provincialism, Biostratigraphy, Phytogeography, India.

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साराँश

गोंडवाना वनस्पतिजातों में प्रान्तीयता

हरिकृष्ण माहेश्वरी

अँसेलियन से रिहँटियन आयु के भारतीय गोंडवाना अवसादों में एक विशेष वनस्पतिजात के पादप-अवशेष मिलते हैं जो कि संरचना की दृष्टि से एक जैसे हैं। क्रमशः परमी एवं त्रिसंघी कल्पों में वस्तुतः दो वनस्पतिजातीय समुच्चय—**ग्लॉसॉप्टेरिस** समुच्चय एवं **डाइक्रोइडियम** समुच्चय, अभिनिर्धारित किये जा सकते हैं। गोंडवाना महासमूह के विभिन्न शैल-समूहों में अश्मित पौधों के वितरण से सम्बद्ध आँकड़ों के संश्लेषण से प्रान्तीयता की स्पष्ट झलक मिलती है विशेषतया बराकार शैल-समूह में। अभी तक यह स्पष्ट नहीं हो पाया है कि यह प्रान्तीयता वास्तविक है अथवा आभासी।

THE term Gondwana floras relates to the succession of remnants of a vegetation that have been recorded from the Gondwana sediments of India. The unit Gondwana was originally proposed for a group of sediments laid down in a primarily fresh-water environment (Medlicott, 1872—unpublished). In subsequent years three distinct floral associations were recorded from the Gondwana group of sediments, within a time slice of Late Carboniferous to Early Cretaceous (see Lele, 1976). The composition of the contained floras led to the inclusion of certain coastal marine sedimentaries of Cretaceous age, and also a group of sediments of Early Permian age from western Himalayan region within the purview of the Gondwana. The concepts, limits and extension of the Indian Gondwana have been debated in recent years. One of the proposals fixes the status of the Gondwana as a supergroup comprising an almost continuous sequence of essentially terrigenous sediments, the deposition of which was preceded and followed by large hiatuses. The time slot of the Gondwana Supergroup in India has now been fixed between earliest Permian and latest Triassic (Venkatachala & Maheshwari, 1991) The Gondwana sediments were deposited in the three major grabens, viz., Damodar, Son-Mahanadi and Pranhita-Godavari, besides several smaller basins.

The Gondwana Supergroup in the Damodar Graben is classified as follows:

	hiatus	
Mahadeva Group	T_3	Supra Panchet
	T_2	Formation[1]
Panchet Group	T_1	Hirapur Formation[2]
		Maitur Formation[3]

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Damuda Group	P_2	Raniganj Formation[4]
		Kulti Formation[5]
	P_1	Barakar Formation[6]
Talchir Group	P_1	Talchir Formation
	hiatus	

1) Equivalent formations—Dubrajpur (Rajmahal Basin), Tiki and Parsora (Son Graben), Pachmarhi and Denwa (Satpura Graben), and Dharmaram, Maleri and Bheemaram (Pranhita-Godavari Graben).
2) Equivalent to top of 'Kamthi' (Godavari Graben).
3) Equivalent to Upper 'Kamthi' (Godavari Graben) and Upper Hinjir (Mahanadi Graben).
4) Equivalent formations—Pachwara (Rajmahal Basin), Pali (Son Graben), Hinjir (Mahanadi Graben), Kamthi (Wardha Coalfield), Bijori (Satpura Graben).
5) Also known as Barren Measures (Damodar Graben) or Motur (Satpura Graben). May also include basal part of the 'Kamthi' (Godavari Graben).
6) Basal part sometimes known as Karharbari 'Formation'. Equivalent formations are Nishatbagh and Mamal (Kashmir Valley, Pir Panjal and Parauthochtone), Khelong/Rilu (eastern Himalaya).

After the initial report of plant fossils from the Raniganj Coalfield (Brongniart, 1828), mega- and micro-fossils have been reported from almost all the horizons (see Lakhanpal, Maheshwari & Awasthi, 1976; Chandra & Singh, 1989; Maheshwari, Singh & Bajpai, 1989; Bajpai, 1990; Bajpai & Tewari, 1990; Chandra, Srivastava & Singh, 1990; Prasad & Maithy, 1990; Singh & Bajpai, 1990; Singh & Chandra, 1990; Bajpai & Maheshwari, 1991; Chandra & Tewari, 1991; Srivastava, 1991; Kapoor, Bajpai & Maheshwari, 1992; Maheshwari & Bajpai, 1992, etc.).

Table 1 lists plant megafossils known so far from different formations of the Gondwana Supergroup. Tables 2-15 list plant megafossils for each important formation and show their areal distribution.

In recent years a few papers have analysed the palaeobotanical implications or rather palaeobotanical evidences on the northern limits of the Indian Plate during the Gondwana period. Use of palaeobotanical data for phytogeographic considerations one can understand. But to demarcate plate boundaries on the basis of elements of a land flora involves two assumptions or surmises:

(i) One particular type of plant association could not transcend plate boundaries, and
(ii) More than one plant association could not thrive on each palaeoplate.

These surmises seem to be natural corollaries of long held belief that the Gondwana Supercontinent had a uniform vegetation all over. The area of the Gondwana Supercontinent comprising all the continents of the Southern Hemisphere and India should total to some millions of square kilometres, with a south-north extent from the South Polar Region to Tropic of Cancer atleast. If the accretion of Turkey, Afghanistan, Tarim Basin, etc. as a part of the Indian Plate is also accepted, the northern margin of this plate may well have reached the Permian equator. It seems improbable that such a huge landmass had a uniform vegetation cover, a vegetation that did not show any provincialism even at micro-level. One would rather expect some degree of provincialism in floral composition in an area, much smaller than that covered by Gondwanan India.

The distribution of the vegetation undoubtedly is an active attribute of land-sea distribution, and climatic thermometry, i.e., palaeolatitudes. It does not seem plausible that each taxon of land plants could have thrived simultaneously both in cool-temperate and subtropical-tropical areas and that each taxon would have populated the Gondwana Supercontinent all over, at the same time.

The concept of the so-called mixed floras seems to have complicated our understanding of the phytogeography of the Permian period. For example, the genus *Glossopteris* established for certain tongue-shaped leaves with reticulate venation and a midrib is the most characteristic element of the Permian flora of Gondwana Supercontinent. In the 1930s similar leaves were recorded in the Angaran Flora. Zimina (1967) reported similar leaves from Permian of Siberia. I have examined these specimens, and had I not known from where these specimens have come, I would have unhesitatingly accepted their placement under the Gondwanan *Gangamopteris* and *Glossopteris*. However, hardly any palaeobiogeographer accepts that these leaves are same as the Gondwanan ones, probably because such an acceptance would not fit in with the concept of Continental Drift. But, reports of *Glossopteris* from Turkey or Indonesia are accepted even though there is no evidence to show that the *Glossopteris*-like leaves from these areas belong to the same lineage as the Gondwanan *Glossopteris* (see Maheshwari & Bajpai, 1988). A leaf from the Jurassic of Oaxaca, Mexico, that has all the morphographical characters of a Gondwanan *Glossopteris* is not accepted as a record of this genus, because the genus is not 'expected' to have continued into the Jurassic. There is a recent veiw that the genus *Lesleya* from the

Table 1—Distribution of plant megafossils through Indian Gondwana

	TALCHIR	KARHARBARI	BARAKAR	KULTI	RANIGANJ	KAMTHI	BIJORI	PALI	PACHHWARA	HINJIR	MAITUR	HIRAPUR	PARSORA	TIKI	MALERI
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Mesembrioxylon malerianum															.....
Cladophlebis indica															.....
Noeggerathiopsis sp.											?				
Spermatites orbicularis														cf	
Baiera sp.														.....	
Baieroxylon cicatricum														.....	
Dicroidium coriaceum														.....	
Dicroidium giarensis														.....	
Dicroidium zuberi														.....	
Heidiphyllum singhii														.....	
Lepidopteris madagascariensis														.....	
Lepidopteris stormbergensis														.....	
Pagiophyllum bosei														.....	
Rissikia denticulata														.....	
Rissikia raoi														.	
Sphenobaiera janarensis														.	
Xylopteris sp.														.....	
Yabiella indica														.....	
Diplasmiophyllum hughesii													.....	.....	
Dicroidium odontopteroides											?		.....	cf	
Baiera indica													.....		
Cordaicarpus chichariensis													.....		
Dicroidium sahnii											?		.....		
Ginkgoites goiraensis													.....		
Heidiphyllum taeniatum													.....		
Lycopodites sahnii													.		
Marattiopsis sp.													.....		
Neocalamites foxii													.....		
Parsorophyllum indicum													.....		
Pterophyllum sahnii													.....		
Samaropsis srivastavae													.....		
Cladophlebis shensiensis													cf		
Dicroidium feistmantelii													cf		
Dicroidium sp.												?			
Heidiphyllum sp.											.....				
Lepidopteris sp.											.....				
Pecopteris concinna											.....				
Taeniopteris stenoneura											.....				
Kendostrobus sp.											?				
Pantopteris gracilis										.....			.....		
Denkania indica										.....					
Eretmonia hinjridaensis										.....					
Eretmonia ovata										.....					
Eretmonia utkalensis										.....					
Glossopteris acuminata										.....					
Glossopteris dhenkanalensis										.....					
Glossopteris hinjridaensis										.....					
Glossopteris inaequalis										.....					
Glossopteris kamthiensis										.....					
Glossopteris maheshwarii										.....					
Glossopteris utkalensis										.....					
Glossotheca immanis										.....					
Glossotheca orissiana										.....					
Glossotheca utkalensis										.....					

Contd.

Table 1—Contd.

	TALCHIR B	KARHARBARI C	BARAKAR D	KULTI E	RANIGANJ F	KAMTHI G	BIJORI H	PALI I	PACHHWARA J	HINJIR K	MAITUR L	HIRAPUR M	PARSORA N	TIKI O	MALERI P
Handapaphyllum indicum										.....					
Indocarpus elongatus										.....					
Khania dhenkanalensis										.....					
Lidgettonia indica										.....					
Lidgettonia mucronata										.....					
Neomariopteris khanii									cf	.....					
Raniganjia etheridgei										.....					
Scutum elongatum										.....					
Scutum indicum										.....					
Scutum sahnii										.....					
Senia reticulata										.....					
Sphenophyllum utkalensis										.....					
Surangephyllum elongatum										.....					
Utkalia dichotoma										.....					
Anthrophyopsis sp.										.....					
Lelstotheca robusta									.....	.....					
Dichotomopteris bansloiensis									.....						
Dichotomopteris ovata									.....						
Glossopteris parallela									.....						
Glossopteris wilkinsonii									.....						
Glossopteris gopadensis								.....	.....						
Samaropsis raniganjensis								.....	.....						
Algacites oogonifera								.....							
Chakrea papillosa								.....							
Cordaicarpus ovatus								.....							
'Dicroidium' gopadensis								.....							
'Dicroidium' nidpurensis								.....							
'Dicroidium' papillosum								.....							
Glossopteris formosa major								.....							
Glossopteris nilssonioides								.....							
Glossopteris papillosa								.....							
Glossopteris rewaensis								.....							
Glossopteris senii								.....							
Glossopteris sidhiensis								.....							
Glottolepis glabrosa								.....							
Glottolepis ovata								.....							
Glottolepis rugosa								.....							
Glottolepis sidhiensis								.....							
Glottolepis tuberculata								.....							
Gopadia coriacea								.....							
Gopadia papillata								.....							
Hapaticites foliata								.....							
Hapaticites metzgerioides								.....							
Hepaticites nidpurensis								.....							
Hepaticites riccardioides								.....							
Lelestrobus pennatus								.....							
Lepidopteris indica								.....							
Nidia ovalis								.....							
Nidispermum glabrosum								.....							
Nidistrobus harrisiana								.....							
Nidpuria problematica								.....							
Marhwaseaphyllum hastatum								.....							
Pantiaspermum cristatum								.....							
Pterophyllum karkatiensis								.....							
Pteruchus gopadensis								.....							

Contd.

Table 1—Contd.

	TALCHIR B	KARHARBARI C	BARAKAR D	KULTI E	RANIGANJ F	KAMTHI G	BIJORI H	PALI I	PACHHWARA J	HINJIR K	MAITUR L	HIRAPUR M	PARSORA N	TIKI O	MALERI P
Pteruchus indicus								.....							
Pteruchus nidpurensis								.....							
Pteruchus thomasii								.....							
Pyriformispermum elongatum								.....							
Rewaphyllum nidpurensis								.....							
Rotundaspermum mucronatum								.....							
Rugapites spherica								.....							
Rugaspermum insigne								.....							
Rugaspermum media								.....							
Rugaspermum obscura								.....							
Rugatheca nidpurensis								.....							
Samaropsis menisca								.....							
Samaropsis surangei								.....							
Satsangia campanulata								.....							
Savitrispermum crateriformis								.....							
Sidiphyllites flabellatus								.....							
Sphagnophyllites triassicus								.....							
Taeniopteris spatulata								?					?		
Dicksonia sp.							.....								
Rhipidopsis densinervis						.....					.....				
Araucarioxylon kothariensis						.....									
Araucarioxylon lathiense						.....									
Araucarioxylon loharense						.....									
Araucarioxylon nandoriense						.....									
Araucarioxylon surangei						.....									
Arauspiropitys indicum						.....									
Australoxylon kanhargaoense						.....									
Australoxylon longicellularis						.....									
Australoxylon wejgaoense						.....									
Baieroxylon multiseriale						.....									
Dadoxylon adhariense						.....									
Dadoxylon chandrapurense						.....									
Dadoxylon maharashtraensis						.....									
Dadoxylon spp.						.....									
Filicites sp.						.....									
Glossopteris musaefolia						.....									
Glossopteris surangei						.....									
Glossopteris venustus						.....									
Kamthioxylon adhariensis						.....									
Kaokoxylon pseudotrimedullaris						.....									
Nandorioxylon saksenae						.....									
Planoxylon indicum						.....									
Prototaxoxylon gondwanense						.....									
Prototaxoxylon mahabalei						.....									
Prototaxoxylon maithyi						.....									
Prototaxoxylon uniseriale						.....									
Rhizoctonia nandoriense						.....									
Sclerospiroxylon marguerierae						.....									
Taxopitys indica						.....									
Taxopitys surangei						.....									
Trigonomyelon kamthiensis						.....									
Zalesskioxylon lepekhinae						.....									
Zalesskioxylon simplexum						.....									
Gangamopteris hughesii			?		cf	.....									

Contd.

Table 1—Contd.

	TALCHIR	KARHARBARI	BARAKAR	KULTI	RANIGANJ	KAMTHI	BIJORI	PALI	PACHHWARA	HINJIR	MAITUR	HIRAPUR	PARSORA	TIKI	MALERI
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Dadoxylon chandaensis						?									
Glossopteris stenoneura					.....	.....		.....			.....				
Dichotomopteris ovata					.....				.....						
Raniganjia bengalensis					.....				.....	.....					
Glossopteris divergens					.....				.....						
Glossopteris formosa					.....			.....	.....						
Neomariopteris lobifolia					.....				.....		?				
Phyllotheca griesbachii					.....			.....	.....						
Glossopteris spatulata					.....			.....							
Dichotomopteris lindleyii					.....		.....								
Gangamopteris whittiana					.....		cf								
Glossopteris arberi					.....	.....									
Glossopteris lanceolatus					.....	.....									
Glossopteris mohudaensis					.....	.....									
Glossopteris tenuifolia					.....	.....									
Arberiella vulgaris					.....										
Araucarioxylon bradshawianum					.....										
Araucarioxylon kumarpurense					.....										
Araucarioxylon ningahense					.....										
Araucarioxylon parbeliense					.....										
Araucarioxylon robertianum					.....										
Araucarioxylon semibiseriatum					.....										
Australoxylon ranaensis					.....										
Bankolaea raniganjensis					.....										
Belemnopteris pellucida					.....										
Belemnopteris sagittifolia					.....										
Belemnopteris woodmasoniana					.....										
Bengalia raniganjensis					.....										
Catervoxylon raniganjensis					.....										
Chapmanoxylon indicum					.....										
Chapmanoxylon raniganjensis					.....										
Cornuspermum pennatus					.....										
Cuticulatopteris polymorpha					.....										
Dadoxylon jamudhiense					.....										
Damudopteris bengalensis					.....										
Damudosaurus raniganjensis					.....										
Damudosaurus searsolensis					.....										
Damudoxylon jamuriense					.....										
Damudoxylon lepekhinae					.....										
Damudoxylon waltonii					.....										
Dichotomopteris asansolioides					.....										
Dichotomopteris falcata					.....										
Dichotomopteris major					.....										
Dictyopteridium feistmantelii					.....										
Eretmonia emarginata					.....										
Gangamopteris anthrophyoides					.....										
'Gangamopteris' flexuosa					.....										
Gangamopteris indica					.....										
Glossopteris acaulis					.....										
Glossopteris acuta					.....										
Glossopteris anthrophyoides					.....										
Glossopteris bengalensis					.....										
Glossopteris brongniartii					.....										
Glossopteris clarkei					.....										
Glossopteris contracta					.....										

Contd.

Table 1—Contd.

	TALCHIR	KARHARBARI	BARAKAR	KULTI	RANIGANJ	KAMTHI	BIJORI	PALI	PACHHWARA	HINJIR	MAITUR	HIRAPUR	PARSORA	TIKI	MALERI
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Glossopteris cordiformis					.....										
Glossopteris euryneura					.....										
Glossopteris frondosa					.....										
Glossopteris ghusikiensis					.....										
Glossopteris gigas					.....										
Glossopteris gondwanensis					.....										
Glossopteris isolateralis					.....										
Glossopteris longifolia					.....										
Glossopteris maculata					.....										
Glossopteris major					.....										
Glossopteris nautiyalii					.....										
Glossopteris obscura					.....										
Glossopteris oldhamii					.....										
Glossopteris orbicularis					.....										
Glossopteris petiolata					.....										
Glossopteris pseudocommunis					.....										
Glossopteris radiata					.....										
Glossopteris reticulata					.....										
Glossopteris retusa					.....										
Glossopteris rhabdotaenioides					.....										
Glossopteris sahnii					.....										
Glossopteris sastrii					.....										
Glossopteris searsolensis					.....										
Glossopteris shailae					.....										
Glossopteris srivastavae					.....										
Glossopteris subtilis					.....										
Glossopteris taeniopteroides			?		.....										
Glossopteris tenuinervis					.....										
Glossopteris tortuosa			?		.....										
Glossopteris transversalis					.....										
Glossopteris varia					.....										
Glossopteris verticillata					.....										
Glossopteris vulgaris					.....										
Glossopteris waltonii					.....										
Gondwanolepis lanceolata					.....										
Gondwanolepis linearis					.....										
Gondwanolepis oblongovata					.....										
Jambadostrobus pretiosus					.....										
Kaokoxylon zalesskyi					.....										
Kendostrobus cylindricus					.....										
Kendoxylon fissilis					.....										
Leleopteris ovata					.....										
Leleopteris srivastavae					.....										
Lithangium indicum					.....										
Lithangium ovoides					.....										
Lithangium surangei					.....										
Mahudaea senii					.....										
Megaporoxylon kraeuselii					.....										
Ottokaria raniganjensis					.....										
Palaeospiroxylon heterocellularis					.....										
Palaeovittaria raniganjensis					.....										
Paracatervoxylon biseriatum					.....										
Paracatervoxylon raniganjensis					.....										
Parapalaeospiroxylon burmundiaensis					.....										
Pecopteris affinis					.....										

Contd.

Table 1—Contd.

	TALCHIR B	KARHARBARI C	BARAKAR D	KULTI E	RANIGANJ F	KAMTHI G	BIJORI H	PALI I	PACHHWARA J	HINJIR K	MAITUR L	HIRAPUR M	PARSORA N	TIKI O	MALERI P
Platycardia bengalensis					.....										
Plumsteadia indica					.....				?						
Plumsteadia lanceolata					.....										
Plumsteadiostrobus ellipticus					.....										
Polytheca elongata					.....										
Protophyllocladoxylon indicum					.....										
Pterophyllum burdwanense					.....										
Pteronilssonia gopalii					.....										
Pterygospermum raniganjense					.....										
Ranoxylon bengalensis					.....										
Rhabdotaenia fibrosa					.....										
Samaropsis raniganjensis					.....										
Scirroma angusta					.....										
Scirroma ventilebra					.....										
Scutum draperium					.....										
Scutum dutoitides					.....			.....							
Scutum leslium					.....										
Scutum stowanum					.....										
Senotheca murulidihensis					.....										
Searsolia oppositifolia					.....										
Stephanostoma crystallinum					.....										
Trithecopteris gondwanensis					.....										
Venustostrobus ghusikensis					.....										
Venustostrobus indicus					.....										
Vertebraria raniganjensis					.....										
Vertebraria myelonis					.....										
Zalesskioxylon gondwanensis					.....										
Zalesskioxylon raniganjensis					.....										
Zalesskioxylon uniseriatum					.....										
Glossopteris fibrosa					cf										
Dadoxylon ghorawariense				.....											
Cyclodendron leslei				.....					.....						
Trizygia speciosa			.....		.....		.....	.....	.....	?					
Dadoxylon barakarense			.....						.....						
Dictyopteridium sporiferum			.....		.....			.....		.....					
Glossopteris conspicua		?	.....	.....	.....	.....	.....			.....	.....				
Glossopteris elongata			.....	.....	.....		.....	.....	.....	.....	?				
Neomariopteris polymorpha			.....		.....			.....		.....					
Pseudoctenis ballii			.....					.....		.....					
Glossopteris leptoneura			.....		.....	.....	.....				?				
Asansolia phegopteroides			.....		.....	.....			.....						
Glossopteris emarginata			.....		.....				.....						
Glossopteris feistmantelii			.....					.....	.....						
Rhabdotaenia danaeoides		?	.....	.....	.....	.....		.....	.....						
Glossopteris intermittens			.....		.....			.....							
Glossopteris stenoneura			.....		.....			.....							
Glossopteris stricta			.....		.....	.....		.....							
Squamae gymnospermarum			.....					.....							
Glossopteris raniganjensis			.....	.....	.....	.....	.....								
Alethopteris spp.			.....			.....									
Damudoxylon parenchymosum			.....			.....									
Pterophyllum spp.			.....			.....									
Sphenophyllum churulianum			.....			.....									
Sphenophyllum crenulatum			.....		.....	.....									
Glossopteris ampla			.....	.....	.....										

Contd.

Table 1—Contd.

	TALCHIR B	KARHARBARI C	BARAKAR D	KULTI E	RANIGANJ F	KAMTHI G	BIJORI H	PALI I	PACHHWARA J	HINJIR K	MAITUR L	HIRAPUR M	PARSORA N	TIKI O	MALERI P
Glossopteris ingens			.....		.....										
Glossopteris intermedia			.....		.....					?					
Glossopteris linearis			.....		.....										
Glossopteris nimishea			.....		.....										
Glossopteris pandurata			.....		.....										
Palaeovittaria kurzii			.....		.....										
Glossopteris barakarense			.....	.....											
Alatocarpus indicus			.....												
Angiopteridium infarctum			.....												
Araucarioxylon kharkhariense			.....												
Barakaria dichotoma			.....												
Birbalsahnia divyadarshanii			.....												
Dadoxylon bengalense			.....												
Eretmonia karanpuraensis			.....												
Gangamopteris chatterjei			.....												
Ginkgoites huraensis			.....												
Ginkgoites veekaysinghii			.....												
Glossopteris bargoensis			.....												
Glossopteris churiensis			.....												
Glossopteris fuchsii			.....												
Glossopteris karanpuraensis			.....												
Glossopteris ornatus			.....												
Glossopteris parallela			.....												
Glossopteris saksenae			.....												
Gondwanophyllites dissectus			.....												
Gondwanophyton indicum			.....												
Gondwanophyton sp.			.....												
Indoxylon canalosum			.....												
Kashmiropteris meyenii			.....												
Kawizophyllum dunpathriensis			.....												
Lepidostrobus kashmirensis			.....												
Lobatannularia ensifolia			.....												
Lobatannularia lingulata			.....												
Lobatannularia sinensis			.....												
Lelstotheca striata			.....												
Lidgettonia sp.			.....												
Neomariopteris barakarensis			.....												
Ottokaria bihariensis			.....												
Parapalaeoxylon ghorawariense			.....												
Parapalaeoxylon gondwanense			.....												
Platyphyllum bokaroensis			.....												
Polysolenoxylon jhariense			.....												
Psygmophyllum haydenii			.....												
Psygmophyllum hollandii			.....												
Psygmophyllum sahnii			.....												
Rajahia mamalensis			.....												
Pterygospermum spiculatum			.....												
Rhipidopsis densinervis			.....												
Rhipidopsis gondwanensis			.....												
Samaropsis johillensis			.....												
Saportaea nervosa			.....												
Saportaea reniformoides			.....												
Scutum sp.			.....												
Spermatites indicus			.....												
Sphenophyllum thonii			.....												

Contd.

Table 1—Contd.

	TALCHIR	KARHARBARI	BARAKAR	KULTI	RANIGANJ	KAMTHI	BIJORI	PALI	PACHHWARA	HINJIR	MAITUR	HIRAPUR	PARSORA	TIKI	MALERI
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Taeniopteris kashmirensis			.....												
Trizygia maithyiana			.....										cf		
Veekaysinghia durgavatiae			.....												
Walkomiella indica			.....												
Walkomiellospermum indicum			.....												
Cyathea tchihatcheffi			cf		cf										
Gangamopteris kashmirensis			cf												
Glossopteris angustifolia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	?	.....			
Schizoneura gondwanensis	.....	.....	.....		.....	.....	.....	.....	.....	.....	.....	.....			
Glossopteris communis	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	?				
Glossopteris browniana	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	?		?		
Neomariopteris hughesii	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....					
Phyllotheca australis	.....	.....	.....		.....	.....			?	.....					
Glossopteris damudica	.....	.....	.....	.....	.....		.....	.....	.....	cf		?			
Squamae integerrima	.....				.....			.....							
Rhipidopsis gondwanensis	.....	.....				.....									
Glossopteris decipiens	.....	.....	?		.....										
Glossopteris taenioides	.....	.....			.....										
Neomariopteris talchirensis	.....	.....			.....										
Alatocarpus jobillensis	.....	.....													
Cordaicarpus zeilleri	.....	.....													
Euryphyllum whittianum	.....	.....													
Glossopteris angusta	.....	.....													
Glossopteris giridihensis	.....	.....													
Glossopteris karharbariensis	.....	.....													
Glossopteris longicaulis	.....	.....									?				
Rubidgea obovata	.....	.....													
Sphenophyllum gondwanensis	.....	.....													
Dadoxylon indicum	.....	cf													
Buriadia sewardii	.....	?			?			?							
Arberia indica	.....														
Arberia surangei	.....														
Birsinghpuria indica	.....														
Botrychiopsis valida	.....														
Bulbospermum surangei	.....														
Buriadia florinii	.....														
Buriadia fragilis	.....														
Capsulites gondwanensis	.....														
Cardiocarpus indicus	.....														
Caulophyllites indica	.....														
Cheirophyllum lacerata	.....														
Cordaicarpus karharbariense	.....														
Cordaicarpus zeilleri	.....														
Cordaites stoliczkanus	.....														
Dolianitia karharbariense	.....														
Euryphyllum obovatum	.....														
G. cyclopteroides auriculata	.....														
Gangamopteris fibrosa	.....														
Gangamopteris gondwanensis	.....														
Gangamopteris hispida	.....														
Gangamopteris karharbariensis	.....														
Gangamopteris kashmirensis	.....														
Gangamopteris media	.....														
Gangamopteris mucronata	.....														
Gangamopteris oblanceolata	.....														

Contd.

Table 1—Contd.

	TALCHIR B	KARHARBARI C	BARAKAR D	KULTI E	RANIGANJ F	KAMTHI G	BIJORI H	PALI I	PACHHWARA J	HINJIR K	MAITUR L	HIRAPUR M	PARSORA N	TIKI O	MALERI P
Gangamopteris obtusifolia		.....													
Gangamopteris papillosa		.....													
Gangamopteris srivastavae		.....													
Ginkgophyton sp.		.....													
Giridia indica		.....													
Glossopteris jayantiensis		.....													
Glossopteris nishatbaghensis		.....													
Glossopteris recurva		.....													
Glossopteris spathulocordata		.....													
Glossopteris zeilleri		.....													
Karharbariospermum surangei		.....													
Maheshwariella bicornuta		.....													
Maheshwariella spinicornuta		.....													
Noeggerathiopsis bunburyana		.....													
Noeggerathiopsis conspicua		.....													
Noeggerathiopsis fibrosa		.....													
Noeggerathiopsis gondwanensis		.....													
N. hislopii subrhomboidalis		.....													
Noeggerathiopsis indica		.....													
Noeggerathiopsis minor		.....													
Noeggerathiopsis papillosa		.....													
Noeggerathiopsis spathulata		.....													
Noeggerathiopsis whittianum		.....													
Noeggerathiopsis zeilleri		.....													
Otofeistia milleri		.....													
Ottokaria bengalensis		.....													
Ottokaria zeilleri		.....													
Palaeocarpus birsinghpurensis		.....													
Palispermum ovalis		.....													
Palmatophyllites debilis		.....													
Palmatopteris furcata		cf													
Phyllotheca ampla		.....													
Phyllotheca angusta		.....													
Phyllotheca crassa		.....													
Phyllotheca sahnii		.....													
Platycardia jugus		.....													
Retortistoma crystallina		.....													
Rotundocarpus ovatus		.....													
Rotundocarpus striatus		.....													
Rubidgea lanceolatus		.....													
Rubidgea emarginata		.....													
Samaropsis feistmantelii		.....													
Samaropsis ganjrensis		.....													
Schizoneura wardii		.....													
Shivacarpus johillensis		.....													
Shivacarpus latus		.....													
Vertebraria gondwanensis		.....													
Samaropsis parvula		cf	cf		cf		cf	cf							
Nummulospermum bowense		cf													
Schizoneura merianii		cf													
Equisetalean stems	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....		
Glossopteris indica	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	?	?		
Vertebraria indica	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....		
Gangamopteris cyclopteroides	.....	.....	.....	.....	?		?		?		?				
Pantophyllum spatulata	.....	.....	.....	.....	?	?		?	?				?		

Contd.

Table 1—Contd.

	TALCHIR	KARHARBARI	BARAKAR	KULTI	RANIGANJ	KAMTHI	BIJORI	PALI	PACHHWARA	HINJIR	MAITUR	HIRAPUR	PARSORA	TIKI	MALERI
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Gangamopteris angustifolia	.....	.....	.....		?										
Gangamopteris intermedia	.....	.....	.....												
Gangamopteris major	.....	.....	.....												
Cordaicarpus spp.	.....	.....											?		
Gangamopteris buriadica	.....	.....			?										
Gangamopteris clarkeana	.....	.....													
G. cyclopteroides areolata	.....	.....													
G. cyclopteroides attenuata	.....	.....													
G. cyclopteroides subauriculata	.....	.....													
Gangamopteris obliqua	.....	.....													
Maheshwariella furcata	.....	.....													
Samaropsis goraiensis	.....	.....													
Arberia umbellata	.....	cf													
Gangamopteris spathulata	cf	.....	?												
G. cyclopteroides acuminata	.....														
Paranocladus? indica	.....														
G. cyclopteroides cordifolia	.....														
G. cyclopteroides crassinervis	.....														
Samaropsis sp.	cf										cf				
Talchirospermum indicum	.....														

Table 2—Geographical distribution of plant fossils in the Talchir Formation

TAXA/AREA	KARANPURA	GIRIDIH	AURANGA	SINGRAULI	CHIRIMIRI	PALI	TALCHIR
Arberia umbellata						•••	
Cordaicarpus spp.			•••		•••		
Cordaites (Pantophyllum) spatulata	•••	•••	•••	•••		•••	•••
Gangamopteris angustifolia		•••					•••
Gangamopteris buriadica	•••						
Gangamopteris clarkeana					•••		
Gangamopteris cyclopteroides	•••	•••	•••	•••	•••	•••	
G. cyclopteroides acuminata	•••		•••				
G. cyclopteroides areolata	•••						
G. cyclopteroides attenuata	•••		•••	•••		•••	
G. cyclopteroides cordifolia	•••		•••				
G. cyclopteroides crassinervis	•••						
G. cyclopteroides subauriculata	•••		•••				
Gangamopteris intermedia					•••		
Gangamopteris major	•••			•••	•••	•••	
Gangamopteris obliqua	•••						
Gangamopteris spathulata						cf	
Glossopteris indica	•••						
Maheshwariella furcata						•••	
Paranocladus? indica						•••	
Samaropsis goraiensis				cf		•••	
Samaropsis sp.						•••	
Talchirospermum indicum						•••	
Vertebraria indica						•••	

Table 3—Geographical distribution of plant fossils in Karharbari Formation

TAXA/AREA	GIRIDIH	DEOGARH	KARANPURA	RANIGANJ	JHARIA	AURANG	HUTAR	DALTONGANJ	PALI	SINGRAULI	UMARIA	MOHPANI	CHRIMIRI	KASHMIR	ARUNACHAL
Alatocarpus johillensis									****	****					
Arberia indica	****														
Arberia surangei									****						
Arberia umbellata	cf														
Birsinghpuria indica									****						
Botrychiopsis valida	****	****	****	??							cf				
Bulbospermum surangei									****						
Buriadia florinii	****														
Buriadia fragilis								****							
Buriadia sewardii	****		****	****	****					??					
Capsulites gondwanensis									****						
Cardiocarpus indicus	****														
Caulophyllites indica	****														
Cheirophyllum lacerata	****								****						
Cordaicarpus karharbariense	****														
Cordaicarpus zeilleri	****	****						****			****				
Cordaites spatulata	****	****	****	****		****		****	****		****	****	****		
Cordaites stoliczkanus	****														
Dolianitia karharbariensis	****														
Euryphyllum obovatum	****														
Euryphyllum whittianum	****				****	****									
Gangamopteris angustifolia	****	****			****				****		****				
Gangamopteris buriadica	****		??		****										
Gangamopteris clarkeana	****					****							****		
Gangamopteris cyclopteroides	****	****	****	****	****	****	****	****	****	??	****	****	****		****
G. cyclopteroides areolata	****														
G. cyclopteroides attenuata	****				****		****	****			****				
G. cyclopteroides auriculata	****														
G. cyclopteroides subauriculata	****							****	****						
Gangamopteris fibrosa	****														
Gangamopteris gondwanensis	****	??													
Gangamopteris hispida	****												****		
Gangamopteris intermedia	****		??												
Gangamopteris karharbariensis	****								****						
Gangamopteris major	****								****						
Gangamopteris media													****		
Gangamopteris mucronata	****							****							
Gangamopteris oblanceolata	****														
Gangamopteris obliqua	****							****							
Gangamopteris obtusifolia													****		
Gangamopteris papillosa													****		
Gangamopteris spathulata			??						****						
Gangamopteris srivastavae									****						
Ginkgophyton sp.	****														
Giridia indica	****														
Glossopteris angusta	****		??								****				
Glossopteris angustifolia	****								****				****	****	****
Glossopteris browniana	****							****							
Glossopteris communis	****					****		****	****		****		****		****
Glossopteris conspicua															****
Glossopteris damudica	****														****
Glossopteris decipiens	****							****	****						
Glossopteris giridihensis	****														
Glossopteris indica			??					****	****		****		****	****	****
Glossopteris jayantiensis		****													

Contd.

Table 3—Contd.

TAXA/AREA	GIRIDIH	DEOGARH	KARANPURA	RANIGANJ	JHARIA	AURANGA	HUTAR	DALTONGANJ	PALI	SINGRAULI	UMARIA	MOHPANI	CHRIMIRI	KASHMIR	ARUNACHAL
Glossopteris karharbariensis			****								****				
Glossopteris longicaulis	****													****	****
Glossopteris nisbatbaghensis														****	
Glossopteris pandurata	****														
Glossopteris recurva	****														
Glossopteris spathulocordata	****														
Glossopteris taenioides									****						
Glossopteris zeilleri													****		
Maheshwariella bicornuta	****														
Maheshwariella furcata	****														
Maheshwariella spinicornuta									****						
Neomariopteris hughesii						****									
Neomariopteris talchirensis								****							
Pantophyllum bunburyana		****						****							
Pantophyllum conspicua		****													
Pantophyllum fibrosa									****						
Pantophyllum gondwanensis									****						
Pantophyllum indica									****						
Pantophyllum minor									****				****		
Pantophyllum papillosa									****						
Pantophyllum zeilleri	****														
Nummulospermum bowense	cf													??	
Otofeistia milleri	****								****						
Ottokaria bengalensis	****														
Ottokaria zeilleri	****														
Palaeocarpus birsinghpurensis									****						
Palispermum ovalis									****						
Palmatopteris furcata														cf	
Phyllotheca ampla			****												
Phyllotheca australis	****												****		??
Phyllotheca crassa								****							
Phyllotheca sahnii	****								****	****					
Platycardia jugus								****							
Psygmophyllum haydenii														****	
Retortistoma crystallina									****						
Rhipidopsis gondwanensis				****		****									
Rotundocarpus ovatus	****														
Rotundocarpus striatus	****														
Rubidgea emarginata	****														
Rubidgea lanceolatus	****														
Rubidgea obovata	****														
Samaropsis feistmantelii	****	****													
Samaropsis ganjrensis	****					****			****						
Samaropsis goraiensis	****	****						****							
Samaropsis parvula								cf	cf						
Schizoneura merianii	cf														
Schizoneura wardii	****														
Shivacarpus jobillensis									****						
Shivacarpus latus									****						
Squamae integerrima									****						

Euramerican Flora is the ancestor of *Glossopteris* (Leary, 1991). It all seems to be very subjective thinking which does not allow clear demarcation of macro- or micro-palaeophytogeographical provinces.

It is thus axiomatic that for palaeophytogeographic or palaeoclimatic interpretations for the Gondwana period, one should critically assess systematic and taxonomic position of each taxon of

Table 4—Geographical distribution of plant fossils in Barakar Formation

TAXA/AREA	HURA	PACHWARA	RANIGANJ	JHARIA	KARANPURA	BOKARO	DEOGARH	AURANGA	HUTAR	DALTONGANJ	RAMKOLA	SINGRAULI	PALI	UMARIA	CHIRIMIRI	TALCHER	KASHMIR
Alatocarpus indicus												****					
Alatocarpus johillensis												****					
Angiopteridium infarctum			****														
Araucarioxylon barakarense				****													
Araucarioxylon kharkhariense				****													
Asansolia phegopteroides		****															
Barakaria dichotoma								****									
Birbalsahnia divyadarshanii	****																
Buriadia sewardii												??					
Cordaicarpus zeilleri															??		
Cordaites spatulata			****														***
Cyathea tchihatcheffi																cf	
Dadoxylon bengalense				****													
Dadoxylon indicum							****										
Damudoxylon parenchymosum				****													
Dictyopteridium sporiferum			****													****	
Eretmonia karanpuraensis					****												
Euryphyllum elongatum			****														
Gangamopteris chatterjei								****									
Gangamopteris cyclopteroides		??	****					****				****	****		****		****
Gangamopteris hughesii								****									
Gangamopteris kashmirensis																	***
Gangamopteris major																	***
Gangamopteris rajaensis			****														
Gangamopteris spathulata													****				
Giridia barakarensis			****														
Glossopteris ampla						****											
Glossopteris angusta			****														
Glossopteris angustifolia			****			****		****			****		****		****		***
Glossopteris bansloiensis		****															
Glossopteris barakarensis			****		****			****									
Glossopteris bargoensis		****															
Glossopteris browniana		****	****					****			****		****			****	
Glossopteris churiensis			*****					****									
Glossopteris communis	****	****	****		****			***			****	****	****		****	****	***
Glossopteris conspicua			****														***
Glossopteris damudica		****	****					****	****		****		****			****	***
Glossopteris decipiens																****	
Glossopteris elongata		****						****									

Contd.

Table 4—Contd.

TAXA/AREA	HURA	PACHWARA	RANIGANJ	JHARIA	KARANPURA	BOKARO	DEOGARH	AURANGA	HUTAR	DALTONGANJ	RAMKOLA	SINGRAULI	PALI	UMARIA	CHIRIMIRI	TALCHER	KASHMIR
Glossopteris emarginata		****	****														
Glossopteris feistmantelii		****						****									
Glossopteris indica		****	****	****	****	****		****	****		****	****			****	****	
Glossopteris ingens			****														
Glossopteris intermedia																****	
Glossopteris intermittens			****														
Glossopteris karanpuraensis		****			****												
Glossopteris linearis								****									
Glossopteris longicaulis																****	***
Glossopteris nimishea			****					****									
Glossopteris ornatus			****														
Glossopteris parallela		****															
Glossopteris saksenae			****														
Glossopteris stenoneura			****		****												
Glossopteris stricta			****			****		****									
Glossopteris taenioides			****										****				
Glossopteris taeniopteroides		****										cf					
Glossopteris tortuosa			****		****			****									
Gondwanophyllites dissectus			****														
Gondwanophyton indicum			****														
Indoxylon canalosum				****													
Kashmiropteris meyenii																	***
Kawizophyllum dunpathriensis																	***
Lelstotheca robusta	cf	****	****														
Lelstotheca striata			****														
Lepidostrobus kashmirensis																	***
Lidgettonia sp.			****														
Lobatannularia ensifolia																	***
Lobatannularia lingulata																	***
Lobatannularia sinensis																	***
Maheshwariphyllum indicum			****														
Neomariopteris barakarensis								****									
Neomariopteris hughesii		****	****		****												
Neomariopteris polymorpha			****					****								****	
Neomariopteris talchirensis										****						****	
Ottokaria bihariensis								****									
Palaeovittaria kurzii			****														
Palasthalia indica			****														
Parapalaeoxylon ghorawariense															****		

Contd.

Table 4—Contd.

TAXA/AREA	HURA	PACHWARA	RANIGANJ	JHARIA	KARANPURA	BOKARO	DEOGARH	AURANGA	HUTAR	DALTONGANJ	RAMKOLA	SINGRAULI	PALI	UMARIA	CHIRIMIRI	TALCHER	KASHMIR
Parapalaeoxylon gondwanense				****													
Partha raniganjensis			****														
Phyllotheca australis			****	****											****		
Phyllotheca griesbachii													****				
Platyphyllum bokaroensis						****											
Polysolenoxylon canalosum				****													
Polysolenoxylon jhariense				****													
Polysolenoxylon kraeuselii				****													
Pseudoctenis ballii								****									
Psygmophyllum haydenii																	***
Psygmophyllum hollandii																	***
Psygmophyllum sahnii																	***
Rajahia mamalensis																	***
Pterophyllum spp.								****									
Pterygospermum spiculatum			****														
Rhabdotaenia danaeoides		****						****									
Rhipidopsis gondwanensis			****					****									
Samaropsis johillensis													****				
Samaropsis parvula													cf				
Schizoneura gondwanensis		****				****		****					****		****	****	
Scutum barakarensis			****														
Spermatites indicus						****											
Sphenophyllum churulianum			****														
Sphenophyllum crenulatum			****														
Sphenophyllum gondwanensis		****															
Squamae gymnospermarum			****														
Trizygia maithyiana			****														
Trizygia speciosa						****		****								****	
Veekaysinghia durgavatiae	****																
Vertebraria indica		****	****	****	****	****		****	****		****		***		****	****	
Walkomiella indica																	
Walkomiellospermum indicum																	

Table 5—Geographical distribution of plant fossils in Kulti Formation

TAXA/AREA	RANIGANJ	JHARIA	KARANPURA	AURANGA	CHIRIMIRI
Boldibadendron raniganjensis	****				
Cordaites spatulata			****		
Cyclodendron leslei	****	****			
Dadoxylon ghorawariense					****
Gangamopteris cyclopteroides	****		cf	****	
Glossopteris ampla	****	****			
Glossopteris angustifolia			****		
Glossopteris browniana		****		****	
Glossopteris communis	****	****	****		
Glossopteris conspicua			****		****
Glossopteris damudica	****		****		
Glossopteris decipiens		****			
Glossopteris elongata			****		
Glossopteris indica		****	****		****
Neomariopteris hughesii		****			
Rhabdotaenia danaeoides			****		

Table 6—Geographical distribution of plant fossils in Raniganj Formation

TAXA/AREA	RANI-GANJ	JHARIA	KARAN-PURA	BOKARO	AURANGA	HUTAR	RAMKOLA
Araucarioxylon bradshawianum	****						
Araucarioxylon kumarpurense	****	****					
Araucarioxylon ningahense	****						
Araucarioxylon parbeliense	****						
Araucarioxylon robertianum	****						
Araucarioxylon semibiseriatum	****						
Arberiella vulgaris	****						
Asansolia phegopteroides	****				??		
Australoxylon ranaensis	****						
Bankolaea raniganjensis		****					
Belemnopteris pellucida	****						
Belemnopteris sagittifolia	****						
Belemnopteris woodmasoniana	****						
Bengalia raniganjensis	****						
Buriadia sewardii	??						
Catervoxylon raniganjensis	****						
Chapmanoxylon indicum	****						
Chapmanoxylon raniganjensis	****						
Cordaites (Pantophyllum) spatulata	??						
Cornuspermum pennatus		****					
Cuticulatopteris polymorpha	****						
Cyathea tchibatcheffi			****				
Dadoxylon jamudhiense		****					
Damudopteris bengalensis	****						
Damudosaurus raniganjens							
Damudosaurus searsolensis	****						
Damudoxylon jamuriense	****						
Damudoxylon lepekhinae	****						
Damudoxylon waltonii	****						
Dichotomopteris asansolioides	****						
Dichotomopteris falcata	****						
Dichotomopteris lindleyii	****						
Dichotomopteris major	****						
Dichotomopteris ovata	****						
Dictyopteridium feistmantelii	****						
Dictyopteridium sporiferum	****		??		??		
Fretmonia emarginata	****						
Gangamopteris angustifolia	??						

Contd.

Table 6—Contd.

TAXA/AREA	RANI-GANJ	JHARIA	KARAN-PURA	BOKARO	AURANGA	HUTAR	RAMKOLA
Gangamopteris anthrophyoides	****		****				
Gangamopteris buriadica					****		
Gangamopteris cyclopteroides	??				??		
Gangamopteris flexuosa	****						
Gangamopteris hughesii	??						
Gangamopteris indica	****						
Gangamopteris whittiana	****						
Glossopteris acaulis	****						
Glossopteris acuta	****						
Glossopteris ampla	??						
Glossopteris angustifolia	****		****		****	****	
Glossopteris arberi	****						
Glossopteris bengalensis							
Glossopteris brongniartii		****					
Glossopteris browniana	****						
Glossopteris clarkei	****	****					
Glossopteris communis	****		****		****		
Glossopteris conspicua	****		****	****	****		
Glossopteris contracta	****						
Glossopteris cordiformis	****						
Glossopteris damudica	****		****		****		****
Glossopteris decipiens	****			****	****		
Glossopteris divergens	****				****		
Glossopteris elongata	****		****	****	****		
Glossopteris emarginata	****						
Glossopteris euryneura	****						
Glossopteris fibrosa	****						
Glossopteris formosa	****		****				
Glossopteris frondosa	****						
Glossopteris ghusikiensis	****						
Glossopteris gigas	****						
Glossopteris gondwanensis	****			****			
Glossopteris indica	****		****	****	****		****
Glossopteris ingens	****						
Glossopteris intermedia	****						
Glossopteris intermittens	****						
Glossopteris isolateralis	****						
Glossopteris lanceolatus	****						
Glossopteris leptoneura					****		****
Glossopteris linearis	****						
Glossopteris longifolia	****						
Glossopteris macutata	****						
Glossopteris major	****						
Glossopteris nautiyalii	****						
Glossopteris obscura	****						
Glossopteris oldhamii	****						
Glossopteris orbicularis	****						
Glossopteris pandurata	****						
Glossopteris petiolata	****						
Glossopteris pseudocommunis	****						
Glossopteris radiata	****						
Glossopteris reticulata	****						
Glossopteris retusa	****						
Glossopteris rhabdotaenioides	****						
Glossopteris sahnii	****						
Glossopteris sastrii	****						
Glossopteris searsolensis	****						
Glossopteris shailae	****	****					
Glossopteris singularis	****						
Glossopteris spatulata	****						

Contd.

Table 6—Contd.

TAXA/AREA	RANI-GANJ	JHARIA	KARAN-PURA	BOKARO	AURANGA	HUTAR	RAMKOLA
Glossopteris srivastavae	****						
Glossopteris stenoneura	****						
Glossopteris stricta					****		
Glossopteris subtilis					****		
Glossopteris taenioides	****						
Glossopteris taentopteroides	****	****					
Glossopteris tenuifolia	****						
Glossopteris tenuinervis	****						
Glossopteris tortuosa	****						
Glossopteris transversalis	****						
Glossopteris varia		****					
Glossopteris verticillata	****						
Glossopteris vulgaris	****						
Glossopteris waltonii	****						
Gondwanolepis lanceolata		****					
Gondwanolepis linearis		****					
Gondwanolepis oblongovata		****					
Jambadostrobus pretiosus	****						
Kaokoxylon zalesskyi	****						
Kendoxylon fissilis	****						
Kendrostrobus cylindricus	****						
Leleopteris ovata	****						
Leleopteris srivastavae	****						
Lithangium indicum	****						
Lithangium ovoides	****						
Lithangium surangei	****						
Mahudaea senii		****					
Megaporoxylon kraeuselii	****						
Neomariopteris hughesii	****	****					
Neomariopteris lobifolia	****						
Neomariopteris polymorpha	****			****			
Neomariopteris talchirensis	****						
Ottokaria raniganjensis	****						
Palaeospiroxylon heterocellularis	****						
Palaeovittaria kurzii	****						
Palaeovittaria raniganjensis	****						
Paracatervoxylon biseriatum	****						
Paracatervoxylon raniganjensis	****						
Parapalaeospiroxylon burmundiaensis	****						
Pecopteris affinis	****						
Phyllotheca australis	****	****					
Phyllotheca griesbachii	****						
Platycardia bengalensis	****						
Plumsteadia indica	****						
Plumsteadia lanceolata							****
Plumsteadistrobus ellipticus	****						
Polytheca elongata	****						
Protophyllocladoxylon indicum	****						
Pteronilssonia gopalii	****						
Pterophyllum burdwanense	****						
Pterygospermum raniganjense	****						
Raniganjia bengalensis	****						
Ranoxylon bengalensis	****						
Rhabdotaenia danaeoides	****	****			****		
Rhabdotaenia fibrosa	****						
Samaropsis parvula	****						
Schizoneura gondwanensis	****	****	****	****	****	****	****
Scirroma angusta	****						
Scirroma ventilebra	****						
Scutum draperium	****						

Contd.

Table 6—Contd.

TAXA/AREA	RANI-GANJ	JHARIA	KARAN-PURA	BOKARO	AURANGA	HUTAR	RAMKOLA
Scutum dutoitides		****					
Scutum leslium		****					
Scutum stowanum		****					
Searsolia oppositifolia		****					
Senotheca murulidihensis	****						
Sphenophyllum crenulatum		****					
Squamae integerrima		****					
Stephanostoma crystallinum		****					
Trithecopteris gondwanensis	****						
Trizygia speciosa	****						
Venustostrobus ghusikensis	****						
Venustostrobus indicus	****						
Vertebraria myelonis	****						
Vertebraria raniganjensis	****						
Zalesskioxylon gondwanensis	****						
Zalesskioxylon raniganjensis	****						
Zalesskioxylon uniseriatum	****						

Table 7—List of plant fossils from the Bijori Formation, Satpura Basin

Dichotomopteris lindleyii
Dicksonia sp.
Gangamopteris cyclopteroides
Gangamopteris whittiana
Glossopteris angustifolia
Glossopteris browniana
Glossopteris communis
Glossopteris conspicua
Glossopteris damudica
Glossopteris elongata
Glossopteris indica
Glossopteris leptoneura
Glossopteris raniganjensis
Neomariopteris hughesii
Samaropsis parvula
Schizoneura gondwanensis
Trizygia speciosa
Vertebraria indica

Table 8—List of plant fossils from Pachwara Formation, Rajmahal Basin

Asansolia phegopteroides
Cordaites (Pantophyllum) spatulata
Dichotomopteris bansloiensis
Dichotomopteris ovata
Gangamopteris cyclopteroides
Glossopteris angustifolia
Glossopteris browniana
Glossopteris communis
Glossopteris conspicua
Glossopteris damudica
Glossopteris divergens
Glossopteris elongata
Glossopteris emarginata
Glossopteris feistmantelii
Glossopteris formosa
Glossopteris gopadensis
Glossopteris indica
Glossopteris parallela
Glossopteris wilkinsonii
Lelstotheca robusta
Neomariopteris hughesii
Neomariopteris lobifolia
Pachwarophyllum santhalensis
Phyllotheca australis
Phyllotheca griesbachii
Plumsteadia indica
Raniganjia bengalensis
Rhabdotaenia danaeoides
Samaropsis raniganjensis
Schizoneura gondwanensis
Scutum dutoitides
Trizygia speciosa
Vertebraria indica

plant fossils, whether based on a leaf, wood or, pollen. Look-alike plant fossils from disjointed areas do not necessarily mean that they belong to the same plant. For example, the pollen genus *Striatopodocarpites* is known from Euramerican, Angaran,' Cathaysian and Gondwanan floras, yet so far we have no evidence to show that any gymnosperm was common to all these floras. Similarly the pollen genus *Potonieisporites* referred to the conifers was originally reported from the Zechstein of Germany (Bharadwaj, 1964), and at the same time it is an important and characteristic constituent of Early Permian floras of the Gondwana Supercontinent. Again we have no evidence if there

Table 9—Geographical distribution of plant fossils in Pali Formation

TAXA/AREA	PALI	SOHAGPUR	GOPAD-R	NIDHPURI
Chakrea papillosa				****
Cordaicarpus ovatus	****			
'Dicroidium' gopadensis				****
'Dicroidium' nidpurensis			****	****
'Dicroidium' papillosum				****
Dictyopteridium sporiferum	****			
Glossopteris angustifolia	****	****	****	****
Glossopteris browniana	****	****	****	****
Glossopteris communis	****	****	****	
Glossopteris conspicua			****	
Glossopteris damudica	****	****	****	
Glossopteris elongata	****		****	
Glossopteris emarginata			****	
Glossopteris feistmantelii		****		
Glossopteris formosa			****	
Glossopteris formosa major	****		****	
Glossopteris gigas			****	
Glossopteris gondwanensis			****	
Glossopteris gopadensis			****	
Glossopteris indica	****	****	****	
Glossopteris intermedia			****	
Glossopteris leptoneura			****	
Glossopteris linearis			****	
Glossopteris nilssonioides				****
Glossopteris papillosa				****
Glossopteris senii			****	****
Glossopteris sidhiensis				****
Glossopteris spatulata			****	
Glossopteris stenoneura			****	
Glossopteris stricta	****			****
Glossopteris tenuifolia			****	
Glossopteris varia			****	
Glossopteris zeilleri			****	
Glottolepis glabrosa				****
Glottolepis ovata				****
Glottolepis rugosa				****
Glottolepis sidhiensis				****
Glottolepis tuberculata				****
Gopadia coriacea				****
Gopadia papillata				****
Hapaticites foliata				****
Hapaticites metzgerioides				****
Hepaticites nidpurensis				****
Hepaticites riccardioides				****
Lelestrobus pennatus				****
Lepidopteris indica			****	****
Marbwaseaphyllum hastatum				****
Neomariopteris hughesii		****	****	
Neomariopteris polymorpha	****			
Nidia ovalis				****
Nidispermum glabrosum				****
Nidistrobus harrisiana				****
Nidpuria problematica				****
Pantiaspermum cristatum				****
Phyllotheca griesbachii		****		
Pseudoctenis ballii	****			
Pterophyllum karkatiensis	****			
Pteruchus gopadensis				****
Pteruchus indicus				****
Pteruchus nidpurensis				****
Pteruchus thomasii				****

Contd.

Table 9—Contd.

TAXA/AREA	PALI	SOHAGPUR	GOPAD-R	NIDHPURI
Pyriformispermum elongatum				****
Rewaphyllum nidpurensis				****
Rhabdotaenia danaeoides	****			
Rostrumaspermum venkatachalae				****
Rotundaspermum mucronatum				****
Rugapites spherica				****
Rugaspermum insigne				****
Rugaspermum media				****
Rugaspermum obscura				****
Rugatheca nidpurensis				****
Samaropsis menisca	****			
Samaropsis parvula	****			
Samaropsis raniganjensis	****			
Samaropsis surangei	****			
Satsangia campanulata				****
Savitrispermum crateriformis				****
Schizoneura gondwanensis	****	****	****	
Scutum sahnii			****	
Sidiphyllites flabellatus				****
Sphagnophyllites triassicus				****
Squamae gymnospermarum		****		
Squamae integerrima		****		
Taeniopteris spatulata	****			
Trizygia speciosa		****	****	
Vertebraria indica	****	****	****	

was any conifer that was common to Laurasia and Gondwana Supercontinent during Permian. Thus, at macro-level the boundaries between major floristic provinces become blurred due to subjective taxonomic approaches and/or misidentifications.

At the micro-level, for example, during the Gondwana time slice on the Indian subcontinent, the limited spatial distribution of certain elements reflects an incipient to decipherable provincialism. For this one has to consider time slices of reasonable durations only. A phytogeographic reconstruction, say for the Permian Period has no meaning because it would assume that for 40 million odd years there was a uniform distribution of vegetation all over India. Of course, one has also to take into account the fact that a complete sequence of floral succession is yet to be established. As finer stages of Permian are yet to be identified in the Indian Gondwana, a few examples are taken from different formation level units.

Talchir Formation—The formation represents the basal portion of the Indian Gondwana and is usually taken as equivalent of Asselian and Sakmarian stages. The flora of this period was not much diversified and is poorly known. Leaves of the genera *Gangamopteris* and *Pantophyllum* (= *Noeggerathiopsis*) are major components of the flora. No visible provincialism is seen.

Barakar Formation—The Barakar Formation conformably succeeds the Talchir Formation and is equivalent of Artinskian Stage. Some authors classify the lower part of the formation as an independent formation—the Karharbari. This unit does have a distinct floral association and hence here it is considered as a biozone.

The Karharbari biozone is reported from a number of coalfields (Table 3). The common elements of the flora are leaves of the genera *Pantophyllum* (= *Noeggerathiopsis*), *Gangamopteris* and *Glossopteris*. The biozone is best developed in the Giridih Coalfield, where the characteristic elements are *Botrychiopsis, Rubidgea* and *Buriadia*. The first two genera have not been found so far from any other place in India. *Botrychiopsis* is known from Australia and Argentina, and *Rubidgea* from South Africa. The synchroneity of these records with the Giridih record is yet to be established. The genus *Buriadia* is known from the Pali and Ib-River coalfields, as also from the Raniganj Formation of Raniganj Coalfield. The latter record is doubtful. Thus for the Karharbari time slice, the flora of Giridih Coalfield does show a decipherable provincialism.

In the Barakar Formation *sensu stricto*, the genera *Pantophyllum* (= *Noeggerathiopsis*) and *Gangamopteris* became almost extinct; the former genus has recently been recorded from the lower

Table 10—Geographical distribution of plant fossils in 'Kamthi' Formation

TAXA/AREA	GODAVARI	CHANDRAPUR	NAGPUR
Alethopteris spp.	****		
Araucarioxylon kothariensis		****	
Araucarioxylon lathiense		****	
Araucarioxylon loharense		****	
Araucarioxylon nandoriense		****	
Araucarioxylon surangei		****	
Asansolia phegopteroides			****
Australoxylon kanhargaoense		****	
Australoxylon longicellularis		****	
Australoxylon wejgaoense		****	
Baieroxylon multiseriale		****	
Cordaites spatulata			****
Dadoxylon adhariense		****	
Dadoxylon chandaensis		****	
Dadoxylon chandrapurensis		****	
Dadoxylon maharashtraensis		****	
Filicites sp.			****
Gangamopteris hughesii			****
Glossopteris angustifolia		****	
Glossopteris arberi			****
Glossopteris browniana			****
Glossopteris communis			****
Glossopteris conspicua			****
Glossopteris indica		****	****
Glossopteris lanceolatus		****	
Glossopteris leptoneura		****	****
Glossopteris mohudaensis		****	
Glossopteris musaefolia		****	****
Glossopteris raniganjensis		****	
Glossopteris stricta		****	****
Glossopteris surangei		****	
Glossopteris tenuifolia		****	
Glossopteris venustus		****	
Kamthioxylon adhariensis		****	
Kaokoxylon pseudotrimedullaris		****	
Nandorioxylon saksenae		****	
Phyllotheca australis			****
Planoxylon indicum		****	
Prototaxoxylon mahabalei		****	
Prototaxoxylon maithyi		****	
Prototaxoxylon uniseriale		****	
Pterophyllum spp.	****		
Pseudoctensis ballii		****	
Rhabdotaenia danaeoides			****
Rhipidopsis gondwanensis			****
Rhizoctonia nandoriense		****	
Schizoneura gondwanensis		****	
Sclerospiroxylon marguerierae		****	
Taxopitys indica		****	
Taxopitys surangei		****	
Trigonomyelon kamthiensis		****	
Vertebraria indica		****	****
Zalesskioxylon lepekhinae		****	
Zalesskioxylon simplexum		****	

Table 11—Geographical distribution of plant fossils in 'Hinjir' Formation

TAXA/AREA	IB-RIVER	MADHUPUR	HANDAPPA
Anthrophyopsis sp.			****
Asansolia phegopteroides			****
Cyclodendron leslei			?
Denkania indica			****
Dicroidium sp.		****	
Dictyopteridium sporiferum			****
Eretmonia hinjridaensis			****
Eretmonia ovata			****
Eretmonia utkalensis			****
Glossopteris acuminata			****
Glossopteris angustifolia			****
Glossopteris browniana			****
Glossopteris communis		****	****
Glossopteris conspicua			****
Glossopteris damudica			****
Glossopteris dhenkanalensis			****
Glossopteris elongata			****
Glossopteris gigas		****	
Glossopteris hinjridaensis			****
Glossopteris inaequalis			****
Glossopteris indica			****
Glossopteris kamthiensis			****
Glossopteris maheshwarii			****
Glossopteris tenuifolia		****	
Glossopteris utkalensis			****
Glossotheca immanis			****
Glossotheca orissiana			****
Glossotheca utkalensis			****
Handapaphyllum indicum			****
Indocarpus elongatus			****
Khania dhenkanalensis			****
Lelstotheca robusta			****
Lepidopteris sp.		****	
Lidgettonia indica			****
Lidgettonia mucronata			****
Neomariopteris hughesii			****
Neomariopteris khanii			****
Neomariopteris lobifolia		****	****
Neomariopteris polymorpha			****
Pachwarophyllum santhalensis	****		
Pantopteris gracilis			****
Phyllotheca australis			****
Pseudoctenis ballii		****	****
Raniganjia bengalensis			****
Raniganjia etheridgei			****
Samaropsis sp.		****	
Schizoneura gondwanensis			****
Scutum elongatum			****
Scutum indicum			****
Scutum sahnii			****
Senia reticulata			****
Sphenophyllum churulianum			****
Sphenophyllum crenulatum			****
Sphenophyllum utkalensis			****
Surangephyllum elongatum			****
Trizygia speciosa		****	****
Utkalia dichotoma			****
Vertebraria indica		****	****

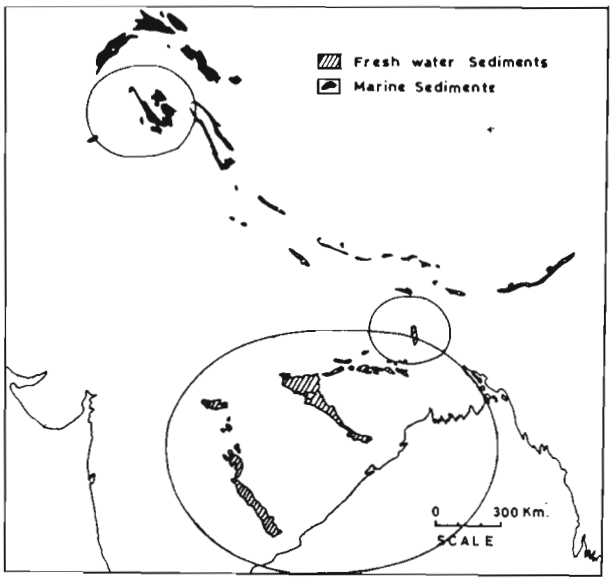
seams of the Raniganj Coalfield (Srivastava, 1992). In general, the flora is dominated by species of the genus *Glossopteris* (Table 4). Three floral provinces

Table 12—Geographical distribution of plant fossils in Maitur Formation

TAXA/AREA	RANI-GANJ	AURA-NGA	RAM-KOLA
Dicroidium odontopteroides			****
Dicroidium sahnii		****	
Gangamopteris cyclopteroides		****	
Glossopteris angustifolia	****	****	****
Glossopteris browniana	****		
Glossopteris communis	****	****	****
Glossopteris conspicua	****		
Glossopteris elongata	****		****
Glossopteris indica		****	****
Glossopteris intermedia	****		
Glossopteris leptoneura			****
Glossopteris longicaulis			****
Heidiphyllum sp.	****		
Kendostrobus sp.	****		
Lepidopteris sp.	****	****	****
Neomariopteris lobifolia			****
Noeggerathiopsis sp.		****	
Pecopteris concinna	****		
Rhipidopsis densinervis		****	
Samaropsis sp.	****		
Schizoneura gondwanensis	****	****	****
Taeniopteris stenoneuron	****		
Trizygia speciosa		****	
Vertebraria indica		****	

Table 13—Geographical distribution of plant fossils in Hirapur/'Upper Kamthi' formations

TAXA/AREA	RANIGANJ	TALCHER
Dicroidium sp.	****	****
Glossopteris angustifolia	****	
Glossopteris damudica	****	
Glossopteris indica	****	
Lepidopteris sp.		****
Neomariopteris hughesii	****	****
Schizoneura gondwanensis	****	



Map 1—The three apparent floristic micro-provinces during the period when Barakar and equivalent formations were deposited.

Table 14—Geographical distribution of plant fossils in Tiki/Upper Kamthi formations

TAXA/AREA	SINGRA-ULI	TALCHER
Baiera sp.	****	
Baieroxylon cicatricum	****	
Dicroidium coriaceum	****	
Dicroidium giarensis	****	****
Dicroidium odontopteroides	****	
Dicroidium superbum		****
Dicroidium zuberi	****	****
Diplasmiophyllum hughesii	****	
Heidiphyllum singhii	****	****
Lepidopteris madagascariensis	****	
Lepidopteris stormbergensis	****	****
Pagiophyllum bosei	****	
Rissikia denticulata	****	
Rissikia raoi	****	
Spermatites indicus	****	
Spermatites orbicularis	****	
Sphenobaiera janarensis	****	
Xylopteris sp.	****	
Yabiella indica	****	****

are apparent, though not necessarily of the same age (Map 1). These provinces are:

(i) Perigondwana (Mamal Formation), with *Lobatannularia, Sphenophyllum, Rajahia* (= *Pecopteris*) and *Kashmiropteris*. All these genera are important constituents of the Cathaysian Flora, and except for the genus *Sphenophyllum* are not known from the Gondwanan flora.

(ii) Northern Rajmahal Basin (Hura Coalfield), with *Sphenophyllum* (dimorphic leaves), *Dactylophyllum digitata*-type, *Saportaea, Psygmophyllum, Rhipidopsis, Ginkgoites, Veekaysinghia, Birbalsahnia,* etc. Leaves resembling those of the genus *Saportaea* have recently been discovered in the fireclays of Auranga Coalfield. The genus is also known from Permian ,of China and United States of America. On the Gondwana Supercontinent, it has been reported from the Triassic of South Africa (Anderson & Anderson, 1989). *Dactylophyllum digitata* is known only from the Late Carboniferous of Australia (Morris, 1975). A *Potonieisporites-Hamiapollenites* palynological association has also been recorded from the Hura Coalfield. These two genera normally are not expected to occur

Table 15—List of plant fossils from Parsora Formation, Son Basin

Baiera indica
Cladophlebis shensiensis
Cordaicarpus chichariensis
Cordaites spatulata
Dicroidium feistmantelii
Dicroidium odontopteroides
Dicroidium sahnii
Diplasmiophyllum hughesii
Ginkgoites goiraensis
Glossopteris browniana
Glossopteris indica
Heidiphyllum taeniatum
Lycopodites sahnii
Marattiopsis sp.
Neocalamites foxii
Pantopteris gracilis
Parsorophyllum indicum
Pterophyllum sahnii
Samaropsis srivastavae
Taeniopteris spatulata
Vertebraria indica

together; in India, *Potonieisporites* is confined to Early Permian, and *Hamiapollenites* to Late Permian.

(iii) Main Gondwana country, including Damodar, Son-Mahanadi and Pranhita-Godavari grabens, and probably also eastern Himalaya. The genera *Barakaria* and *Diphyllopteris* are endemic to the Auranga Coalfield. The only other known record of the genus *Barakaria* is from the Angaran flora (Meyen, 1969).

Raniganj Formation—The flora of the Raniganj and 'equivalent' formations (Table 6-11) is relatively more diversified. Here, too, an incipient provincialism is decipherable. The flora of this formation in the Raniganj Coalfield, where it is best known, has a characteristic element, *Palaeovittaria*, which is not known from any other equivalent bed. The genus has recently been reported from the Barakar Formation of Raniganj Coalfield (Srivastava, 1992), and the Mamal Formation of the Perigondwana (Pant *et al.*, 1991). Alongwith certain other genera, such as, *Belemnopteris, Rhabdotaenia*, the flora of Damodar Graben has a decipherable compositional difference as compared to equivalent floras from other areas. For example, the Hinjir Formation of the Mahanadi Valley has yielded fossils referable to the family Eretmoniaceae (Maheshwari, 1990), which are restricted to this area. The fossils of this family are known only from Queensland in Australia and Natal in South Africa. The upper part of the Pali Formation (Nidhpuri Plant beds) in the Son Graben also contains certain endemic elements, such as the genera *Nidia, Nidistrobus, Satsangia*, etc. The beds also contain 'Thinnfeldia' callipteroides-type of leaves, which in literature have been named as species of the genus *Dicroidium*. The genus *Lelstotheca* is restricted to the Pachwara Formation of Pachwara Coalfield, though it possibly occurs in the Barakar Formation of Hura Coalfield also.

The few examples discussed above reveal that at certain points of time some of the plant taxa had a restricted geographical distribution, and on the basis of such occurrences few incipient or apparent micro-palaeophytogeographical provinces can be delineated. However, much more work needs to be carried out as most of the regions are underexplored, and a complete sequence of floral succession is yet to be established for all the Gondwanan areas.

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