

# Megafloral zonation of Permian-Triassic sequence in the Kamthi Formation, Talcher Coalfield, Orissa

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The Kamthi Formation exposed in the west-central part of Talcher Coalfield is divisible into a Lower and an Upper Member. Megafloral assemblage (Assemblage Zone-I) of the Lower Member is dominated by *Glossopteris* in association with *Trizygia*, *Vertebraria* and *Pseudocatenis*. The Upper Member consists of two distinct sets of lithounits, viz., lower and upper beds. Assemblage Zone-II found in the lower beds of Upper Member is characterised by preponderance of *Glossopteris*; associated elements are : *Cyclodendron*, *Phyllothea*, *Stellothea*, *Trizygia*, *Sphenophyllum*, *Raniganjia*, *Schizoneura*, *Dizeugotheca*, *Neomariopteris*, *Damudopteris*, *Surangephyllum*, *Handapaphyllum*, various glossopterid fructifications, scale leaves, etc. The Assemblage Zone-III also from the lower beds of Upper Member is dominated by *Glossopteris*; associated elements are equisetaceous stems and *Neomariopteris*. However, presence of *Lepidopteris* and ?*Dicroidium* distinguishes Assemblage Zone-III. Assemblage Zone-IV from the upper beds of Upper Member is characterised by abundance of *Dicroidium*, in association with *Lepidopteris*, *Elatocladus*, *Yabiella* and *Desmiophyllum*. On the basis of megafloral assemblages it has been derived that Permian-Triassic Boundary (PTB) in the Talcher Coalfield lies somewhere in the lower beds of the Upper Member of Kamthi Formation.

**Key-words**—Megafloral zonation, Kamthi Formation, Permian-Triassic Boundary, Talcher Coalfield, India.

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## सारांश

उड़ीसा में तलचौर कोयला-क्षेत्र में कामथी शैल-समूह के परमियन-ट्रायसिक अनुक्रम में गुरुवनस्पतिजातीय मंडलन

पंकज कुमार पाल एवं अमित कुमार घोष

तलचौर कोयला-क्षेत्र के पश्चिमी केन्द्रीय भाग में अनावरित कामथी शैल-समूह उपरि एवं अधरि सदस्यों में विभाजित किया गया है। अधरि सदस्य का समुच्चय मंडल-1 ट्राइजीजिया, वर्टीब्रेरिया एवं स््यूडोटीनिस सहित ग्लॉसॉप्टेरिस से प्रभावी है। उपरि सदस्य में दो विभिन्न शैल इकाईयाँ हैं। इससे प्राप्त समुच्चय मंडल-2 भी ग्लॉसॉप्टेरिस से प्रभावी है। इसके अतिरिक्त इसमें साइक्लोडेन्ड्रॉन, फिल्लोथीका, स्टीलोथीका, ट्राइजीजिया, स्फ़ीनोफिल्लम, रानीगंजिया, शाइजोन्युरा, डाइज्यूगोथीका, हंडपाफिल्लम, निओमेरिऑप्टेरिस आदि सहयुक्त अवयव भी पाये गये हैं। इसके अलावा उपरि सदस्य के निचले संस्तरो से प्राप्त समुच्चय मंडल-3 में ग्लॉसॉप्टेरिस की बाहुल्यता है। साथ ही इक्वीसिटेली तने और निओमारिऑप्टेरिस नामक अन्य सहयुक्त अवयव भी मिलते हैं। समुच्चय मंडल-4 लेपिडोप्टेरिस, इलेटोक्लेडस, याबियेल्ला एवं डेस्मिओफिल्लम के साहचर्य में डाइक्रोइडियम से प्रभावी है। उपलब्ध गुरुवनस्पतिजातीय समुच्चय के आधार पर यह निष्कर्ष निकाला गया है कि तलचौर कोयला-क्षेत्र में परमियन-ट्रायसिक सीमा कामथी शैल-समूह के उपरि सदस्य की अधरि संस्तरो में कहीं विद्यमान है।

THE Gondwana rocks in the Talcher Coalfield are represented by a sequence of fluvial sedimentary deposits belonging to the Talchir, Karharbari, Barakar and post-Barakar Formations. The stratigraphic position of the post-Barakar deposits in this coalfield has long been a matter of controversy. Subramanian (1962) and Chakraborty, Das and Banerjee (1967) classified the post-Barakar sequence into Raniganj, Panchet and Mahadeva Formations on the basis of lithological and palaeontological attributes. However,

Raja Rao (1982) considered the entire sequence as a single lithounit, the Kamthi Formation. Chakraborty (1989) mapped the Kamthi Formation exposed in the west-central part of Talcher Coalfield and classified it into a Lower Member and an Upper Member. The Lower Member is about 200 m thick, comprising mainly medium- to coarse-grained, pebbly, cross-bedded, ferruginous sandstones alternating with and containing clasts of greenish-white shales. The Upper Member is also more or less 200 m thick; two

distinct sets of lithologies have been recognised. The lower beds of the Upper Member are represented by medium-grained buff or white, cross-bedded, ferruginous sandstones alternating with thick bands of red and grey shales. The upper beds of the Upper Member are characterised by highly ferruginous, hard and quartzitic sandstones, bands of hard, compact, brown to yellow shales, bands and clasts of lavender and creamy white shales.

From the well-known Hinjrída Gháti locality (near Handapa Village), belonging to the lower beds of Upper Member of Kamthi Formation, a rich assemblage of plant megafossils dominated by *Glossopteris* has been recorded (Subramanian & Rao, 1960; Khan, 1969; Surange & Maheshwari, 1970; Surange & Chandra, 1973a, 1973b, 1973c, 1974a, 1974b, 1974c, 1974d; Maithy, 1977; Chandra & Rigby, 1981; Singh & Chandra, 1987; Ghosh, 1992; and others). Subramanian and Rao (1960) considered these beds as equivalent to Panchet Formation (Lower Triassic). On the other hand, Khan (1969) and Chandra and Rigby (1981) considered those as homotaxial with Raniganj Formation.

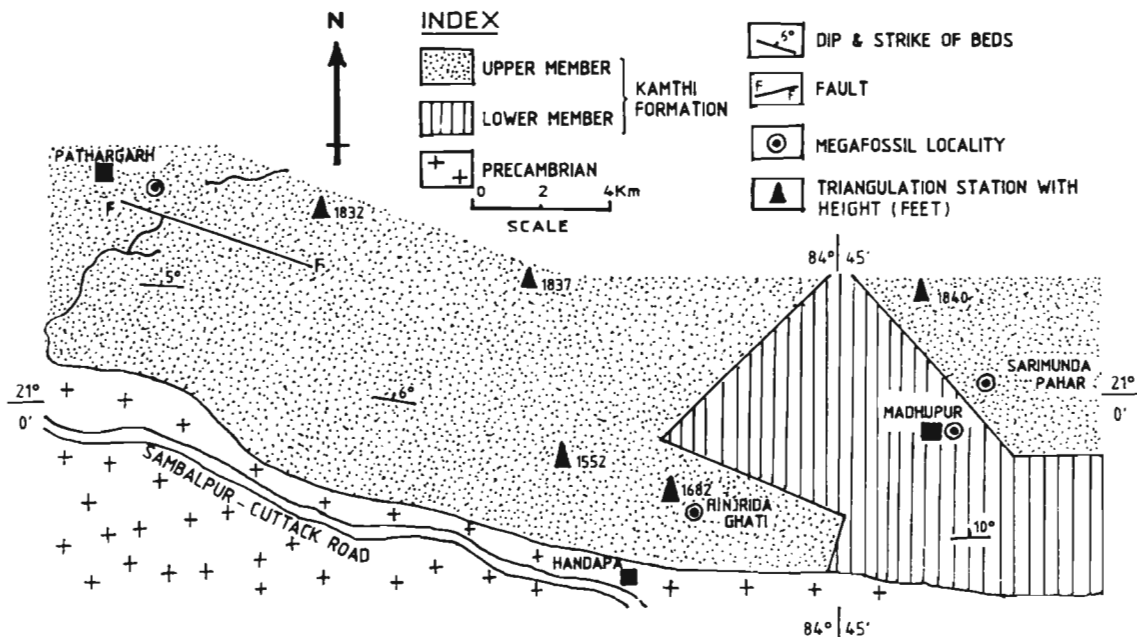
Plant fossils from the Lower Member and upper beds of Upper Member of Kamthi Formation were recorded by Pal *et al.* (1991) and Ghosh (1992). They reported plant megafossils from three new localities viz., (i) about 1 km south-east of Madhupur Village (Lower Member), (ii) southern slope of Sarimunda Hill (lower beds of Upper Member), (iii) about 1.5 km east of Pathargarh Village (upper beds of Upper Member) in addition to the well-known Hinjrída Gháti-locality (Map 1).

In the present paper an attempt has been made to establish the overall lithological and megafloreal successions in the Kamthi Formation of Talcher Coalfield with special reference to demarcate the PTB (Permian-Triassic Boundary) interval.

## MEGAFLORAL ASSEMBLAGES

### Assemblage Zone-I (Madhupur locality)

The assemblage is rich in *Glossopteris* leaves along with *Vertebraria indica*. Other associated forms are: *Trizygia spectosa*, *Neomartiopteris hughesti*, *Glossopteris communis* (Pl. 1, fig. 2; Text-figure 1A), *G. tenuifolia*, *G. gigas* (Pl. 1, fig. 3; Text-figure 1D),



Map 1—Geological map of part of Talcher Coalfield showing megafossil localities.

Text-figure 1-A—*Glossopteris communis* from Madhupur locality. X 1; B. *Eretmonia* - type scale leaf from Madhupur locality. X 2; C. *Pseudoceras ballii* from Madhupur locality. X 1; D. *Glossopteris gigas* from Madhupur locality. X 1; E. *Lepidopteris* sp. from Sarimunda Hill locality. X 2; F. ?*Dicroidium* sp. from Sarimunda Hill locality. X 2; G. *Lepidopteris* sp. cf. *L. stormbergensis* from Pathargarh locality. X 2; H. *Elatocladus* sp. from Pathargarh locality. X 2; I. *Dicroidium giarens* from Pathargarh locality. X 1; J. *Dicroidium zuber* from Pathargarh locality. X 2; K. *Dicroidium superbum* from Pathargarh locality. X 2; and L. *Yabiella* sp. from Pathargarh locality. X 2.



Text-figure 1

*Eretmonta*-type scale leaf (Text-figure 1B) and *Pseudoctenis ballii* (Pl. 1, fig. 4; Text-figure 1C).

### Assemblage Zone-II (Hinjrada Ghati locality)

The assemblage is characterised by the preponderance of glossopterid leaves and fructifications as has already mentioned by Chandra and Rigby (1981) and Singh and Chandra (1987). The other elements known from the Hinjrada Ghati beds are : *Cyclodendron leslii*, *Phyllothea indica*, *Stellothea robusta*, *Sphenophyllum crenulatum*, *S. churultianum*, *Trizygia spectosa*, *Raniganjia bengalensis*, *R. etheridgei*, *Schizoneura gondwanensis*, *Dizeugotheca phegopteroides*, *Neomartiopteris hughesti*, *N. khanii*, *N. lobifolia* (Pl. 1, fig. 1), *Damudopteris bengalensis*, *Pantopteris gracilis*, *Pseudoctenis ballii*, *Surangephyllum elongatum*, *Handapaphyllum indicum*, *Senta reticulata* and *Samaropsis raniganjensis*.

### Assemblage Zone-III (Sarimunda Hill locality)

Fragments of *Glossopteris* leaves are quite common at this locality. Fragmentary specimens of *Neomartiopteris hughesti* and equisetaceous stems with ridges and furrows are also present. Other significant gymnospermous forms present in the assemblage are : *Leptidopteris* sp. (Pl. 1, fig. 6; Text-figure 1E) and *?Dicroitdium* sp. (Pl. 1, fig. 5; Text-figure 1F).

### Assemblage Zone-IV (Pathargarh locality)

The assemblage is dominated by *Dicroitdium*. Other associated elements are : *Leptidopteris* sp. cf. *L. stormbergensis* (Text-figure 1G), *Elatocladus* sp. (Text-figure 1H), *Dicroitdium zuberi* (Pl. 1, figs 8, 9; Text-figure 1J), *D. superbum* (Pl. 1, fig. 10; Text-figure 1K), *D. giarensis* (Pl. 1, fig. 7; Text-figure 1I), *Yabiella* sp. (Pl. 1, fig. 11; Text-figure 1L), *Desmiophyllum* sp. (Pl. 1, fig. 12).

## DISCUSSION

Four distinct megafloral assemblages have been recognised in the Kamthi Formation of Talcher Coalfield (west-central part).

In Assemblage Zone-I (Lower Member, Madhupur locality) *Glossopteris* is the most frequently occurring form. More or less similar assemblage is known from the Raniganj Formation of Damodar Valley Basin (Lele, 1976) which has been dated as Upper Permian.

Assemblage Zone II from Hinjrada Ghati is dominated by *Glossopteris* and its allies in association with other Upper Permian forms. The Assemblage Zone II, like Assemblage Zone I, is also indistinguishable from the assemblage known from the Raniganj Formation, except for the presence of forms like *Surangephyllum elongatum*, *Handapaphyllum indicum* and *Senta reticulata* in the Hinjrada Ghati assemblage.

Assemblage Zone III from the Sarimunda Hill contains *Leptidopteris* sp. and *?Dicroitdium* sp. in association with equisetaceous stems, *Neomartiopteris hughesti* and *Glossopteris* spp. The assemblage Zone III in all probabilities indicates an age younger than that of the Raniganj Formation and comparable with that of the Panchet Formation (Lower Triassic).

Assemblage Zone IV (Pathargarh) represents a *Dicroitdium* rich megaflora. This genus is represented by three species, viz., *D. zuberi*, *D. superbum* and *D. giarensis*. Associated elements are *Leptidopteris* sp. cf. *L. stormbergensis*, *Elatocladus* sp., *Yabiella* sp. and *Desmiophyllum* sp. *Glossopteris* or other Permian forms are totally absent. On the basis of megafloral evidences Pal *et al.* (1991) and Ghosh (1992) considered that the upper beds of Upper Member (Pathargarh) as equivalent to Tiki Formation of South Rewa Gondwana Basin (Upper Triassic). Assemblage Zone IV also resembles those known from the Middle to Upper Triassic of Nymboida Coal Measures and Hawkesbery Sandstone of Australia,

## PLATE 1

1. *Neomartiopteris lobifolia* from Hinjrada Ghati locality. X 1.
2. *Glossopteris communis* from Madhupur locality. X 1.
3. *Glossopteris gigas* from Madhupur locality. X 1.
4. *Pseudoctenis ballii* from Madhupur locality. X 1.
5. *?Dicroitdium* sp. from Sarimunda Hill locality. X 1.
6. *Leptidopteris* sp. from Sarimunda Hill locality. X 1.
7. *Dicroitdium giarensis* from Pathargarh locality. X 1.
- 8, 9. *Dicroitdium zuberi* from Pathargarh locality. X 1.
10. *Dicroitdium superbum* from Pathargarh locality. X 1.
11. *Yabiella* sp. from Pathargarh locality. X 2.
12. *Desmiophyllum* sp. from Pathargarh locality. X 1.

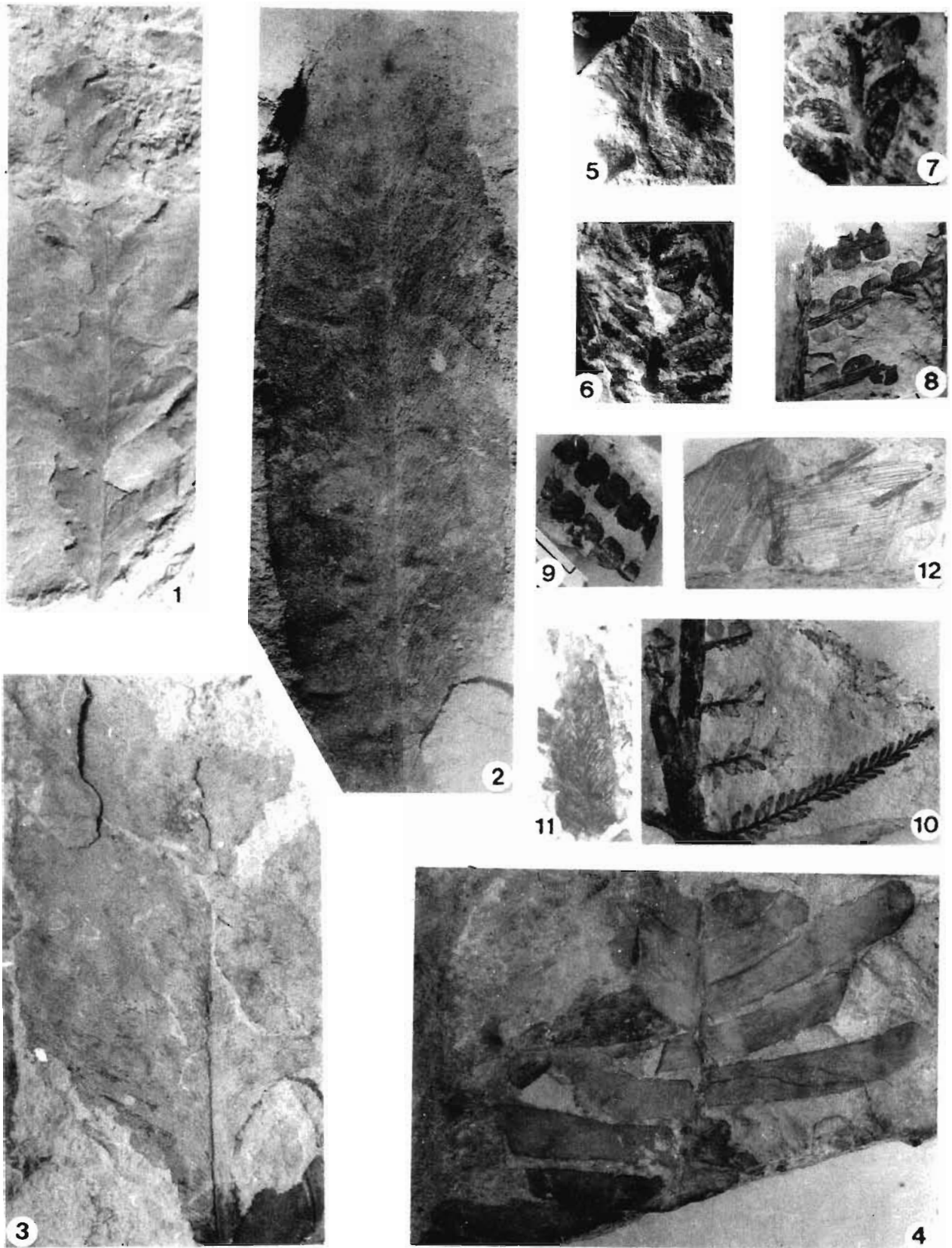


PLATE 1

Table 1—Overall lithological and megafloreal successions in the Kamthi Formation of Talcher Coalfield

		Salient Lithological Features	Megafloreal assemblages	Age	
U P P E R  M E M B E R  L M O E W M E B R E R	U P P E R S	Predominantly ferruginous, hard and quartzitic sandstones, bands of hard and compact brown to yellow shales and bands and clasts of lavender and creamy white shales.	ASSEMBLAGE ZONE-IV (Pathargarh locality) Dominant: <i>Dicroidium</i> Associated elements: <i>Lepidopteris</i> , <i>Elatocladus</i> , <i>Yabiella</i> and <i>Desmiophyllum</i>	U P P E R	T R I A S S I C
	L O W E R  B E D S	Predominantly medium-grained, buff or white cross-bedded ferruginous sandstones alternating with thick bands of red and grey shales.	ASSEMBLAGE ZONE-III (Sarimunda Hill locality) Dominant: <i>Glossopteris</i> Associated elements: Equisetaceous stem, <i>Neomariopteris</i> , <i>Lepidopteris</i> and ? <i>Dicroidium</i>	L O W E R	S S I C
			Assemblage Zone -II (Hinjridda Ghati locality) Dominant: <i>Glossopteris</i> Associated elements: <i>Cyclodendron</i> , <i>Phyllotheba</i> , <i>Stellotheba</i> , <i>Trizygia</i> , <i>Sphenophyllum</i> , <i>Raniganjia</i> , <i>Schizoneura</i> , <i>Dizeugotheca</i> , <i>Neomariopteris</i> , <i>Damudopteris</i> , <i>Surangephyllum</i> , <i>Dictyopteridium</i> , <i>Denkania</i> , <i>Partha</i> , <i>Scutum</i> , <i>Cistella</i> , <i>Khania</i> , <i>Lidgettonia</i> , <i>Gondwanolepis</i> , <i>Kendostrobus</i> , <i>Eretmonia</i> , <i>Indocarpus</i> , <i>Pseudoctenis</i> , <i>Handapaphyllum</i> , <i>Senia</i> and <i>Samaropsis</i>	U P P E R	P E R M I A N
L M O E W M E B R E R	Predominantly medium to coarse grained, pebbly, cross-bedded ferruginous sandstones, alternating with and containing clasts of greenish-white and greyish-white shales.	ASSEMBLAGE ZONE-I (Madhupur locality) Dominant: <i>Glossopteris</i> Associated elements: <i>Trizygia</i> , <i>Neomariopteris</i> , <i>Vertebraria</i> , <i>Eretmonia</i> -type scale leaf and <i>Pseudoctenis</i>			

Esk Trough of Queensland, Cacheuta and Ischigulasto Formations of Argentina, Molteno Formation of South Africa (Townrow, 1966; Retallack, Gould & Runnegar, 1977; Flint & Gould, 1975; Jain & Delevoryas, 1967; Archangelsky, 1968; Anderson & Anderson, 1983).

It can thus be concluded that there is a gradual megafloreal change from Upper Permian to Lower Triassic forms (Assemblage Zone I to Assemblage Zone III) in the Kamthi Formation of Talcher Coalfield. The Upper Triassic megaflorea (Assemblage Zone IV) is clearly distinguishable from the underlying flora. The overall lithological and megafloreal successions in the Kamthi Formation of Talcher Coalfield are represented in Table 1.

#### Probable Permian-Triassic Boundary in the Kamthi Formation

Very few attempts have so far been made to demarcate the Permian-Triassic Boundary in outcrop

sections (Maheshwari & Banerji, 1975; Bharadwaj *et al.* (1979); Kumar, 1996; Pal *et al.*, 1996; Srivastava *et al.*, 1997) of different basins in peninsular India. Maheshwari (1997) analysed the data available from different Permian-Triassic sections of peninsular India and concluded that there is no marine control to precisely demarcate the PTB interval in the basins of Indian peninsula. However, according to Maheshwari (1974) in Damodar Valley Basin the PTB interval is located somewhere across the Raniganj-Maitur transition. In Godavari Graben (Srivastava & Jha, 1995) the PTB interval is within the Kamthi Formation.

In peninsular India, the time of deposition of Raniganj Formation (Upper Permian) and its equivalents is the zenith of *Glossopteris* Flora. Some Upper Permian plants continue in the Lower Triassic (Panchet Formation and its equivalents) accompanied by the introduction of some new elements, viz., *Lepidopteris* and *Dicroidium*; the latter are rare in

occurrence. *Dicroidium* is the characteristic element of southern hemisphere Triassic floras. In the Talcher Coalfield *Leptopteris* and *Dicroidium* first appear in the Assemblage Zone III (Sarimunda Hill). These genera are totally absent in the underlying Hinjrida Ghati beds. Both Hinjrida Ghati and Sarimunda Hill localities expose lower beds of the Upper Member of Kamthi Formation. Though, there is no lithological difference between the two localities, yet, from megafloal evidence it appears that Permian-Triassic Boundary (PTB) in the Talcher Coalfield is located somewhere in the lower beds of the Upper Member of Kamthi Formation.

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