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Stratigraphic position and age of plant bearing Nidpur beds

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The Gopad River Section near Nidpur has yielded a rich and diversified flora showing the dominance of *Dicroidium* associated with the culmination of non-striate bisaccate pollen. Gymnosperms are the main components of this fossil assemblage. *Dicroidium* a widely disseminated taxon in the Gondwanaland has restricted stratigraphical range. It has been considered to be an infallible indicator of Triassic time. Furthermore, the consistency of usual association of *Pteruchus* with *Dicroidium* also supports a Triassic age for Nidpur beds. Confirmatory evidence of Triassic age is also provided by frequent occurrence of *Alisporites indicus* correlated with the variable pollen (*Alisporites*-complex) of *Pteruchus*. The dominant pollen *Satsangisaccites* distinguishes Nidpur assemblage from other palynofloras whereas *Nidipollenites* has now been reported from other Triassic palynofloras of the Indian subcontinent. A stratigraphic position of Nidpur beds between that of Panchet and Parsora formations is advocated; extensive review of data supports a Middle Triassic age.

Key-words—Stratigraphy, *Dicroidium*, Nidpur beds, Middle Triassic (India).

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सारॉंश

निदपुर के अश्मित पादप-धारक संस्तरों की स्तरिकीय स्थिति एवं आयु

श्याम चन्द्र श्रीवास्तव

निदपुर के समीप गोपद नदी खंड से अरेखीय द्विकोष्ठीय परागकणों की बाहुल्यता तथा **डाइक्रोइडियम्** की प्रचुरता से युक्त एक घना वनस्पतिजात उपलब्ध हुआ है। इस समुच्चय में अनावृतबीजीयों का प्रभुत्व है। गोंडवानाभूमि में दूर-दूर तक विस्तृत **डाइक्रोइडियम** स्तरिकीय सीमाओं में ही सीमित है। यह पौधा त्रिसंधी कल्प का अमोघ सूचक माना गया है। इसके अतिरिक्त **टेरूकस** एवं **डाइक्रोइडियम** के साहचर्य से निदपुर संस्तरों की त्रिसंधी आयु की पुष्टी होती है। **टेरूकस** के परागकणों (**ऍलिस्पोराइटिस**-सम्मिश्र) की विविधता तथा **ऍलिस्पोराइटिस इंडिकस** की बाहुल्यता भी त्रिसंधी आयु के प्रमाण जुटाते हैं। **सत्संगीसेक्काइटिस** परागकणों की बाहुल्यता के कारण निदपुर समुच्चय अन्य परागाणविक समुच्चयों से भिन्न है जबकि **निदिपोलिनाइटिस** अब भारतीय उपमहाद्वीप के अन्य त्रिसंधी कालीन परागाणविक वनस्पतिजातों से भी अभिलिखित किया गया है। पंचेत एवं परसौरा शैल-समूहों के मध्य में निदपुर संस्तरों की स्तरिकीय स्थिति की विवेचना की गई है। उपलब्ध आँकड़ों की समीक्षा से निदपुर संस्तरों की मध्य त्रिसंधी आयु की पुष्टी होती है।

THE plant-bearing Nidpur beds, discovered by Satsangi (1964), lie about two and a half kms from north-west corner of village Nidpur on the left bank downstream of Gopad River (24°7′ : 81°54′) in a 7.5 m thick section. In much of the Gopad River region, Raniganj Formation (Upper Permian) is exposed (Hughes, 1881) but rocks ascribed to Panchet Formation are also exposed in Gopad River Section in the southern part of Singrauli Coalfield (Raja Rao, 1983).

The Nidpur plant beds occur nearly in the central part of South Rewa Basin in a small fault bounded outcrop (Srivastava, 1974a, text-fig. 1; Raja Rao, 1983). The lithological succession comprises

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carbonaceous sandy shales of dark and light grey colour with micaflakes superposed by an unfossiliferous massive sandstone consisting of micaceous ferruginous fine to coarse-grained sandstone and light yellow shale (Bharadwaj & Srivastava, 1969). Relationship of the plant-beds with the concealed older formation is not known.

FOSSIL FLORA

The Nidpur plant-beds contain an extremely diverse and rich flora represented by compressions of foliage, detached fertile organs, scale-leaves and seeds, etc. Palynofossils have also been recovered from carbonaceous shale. Systematic palaeofloristic studies by Srivastava (1969, 1971, 1974a, 1974b, 1974c, 1975a, 1975b, 1976, 1977, 1979, 1984a, 1984b, 1984c), Chandra and Satsangi (1965), Bharadwaj and Srivastava (1969), Bose and Srivastava (1970, 1971, 1972, 1973a, 1973b), Srivastava and Maheshwari (1973), Pant and Basu (1973, 1977, 1978, 1979a, 1979b, 1981) and Pant and Pant (1987) have shown the representation of major taxonomic groups in the flora. These are: Phycophyta, Bryophyta, Pteridophyta, Glossopteridophyta, Pteridospermophyta, Cycadophyta, Ginkgophyta and Coniferophyta.

Megaflora

Plant taxa recognized are: *Algacites oogonifera* Pant & Basu, *Hepaticites nidpurensis* Pant & Basu, *H. riccardioides* Pant & Basu, *H. metzeroides* Walton, *H. foliata* Pant & Basu, *Glossopteris senii* Srivastava, *G. papillosa* Srivastava, *G. nidpurensis* Srivastava, *Glossopteris* sp. cf. *G. linearis* Bunbury, *G. nilssonioides* Pant & Pant, *G. sidhiensis* Pant & Pant, *Glossopteris* spp., *Rhabdotaenia* sp., *Lepidopteris indica* Bose & Srivastava, *Bosea indica* Srivastava, *Rugatheca nidpurensis* Pant & Basu, *Dicroidium nidpurensis* Bose & Srivastava, *D. papillosum* Bose & Srivastava, *D. gopadensis* Bose & Srivastava, *Pteruchus nidpurensis* Srivastava, *P. indicus* Pant & Basu, *P. thomasii* Pant & Basu, *P. gopadensis* Pant & Basu, *Marhwaseaphyllum hastatum* Srivastava, *Rewaphyllum nidpurensis* Srivastava, *R. argentinicum* (Archangelsky) Srivastava, *Taeniopteris glandulata* Srivastava, *Nidistrobus harrisianus* Bose & Srivastava, *Nidpuria problematica* Pant & Basu, *Lelestrobus pennatus* Srivastava, *Gopadia coriacea* Srivastava, *G. papillata* Srivastava, *Glottolepis rugosa* Bose & Srivastava, *G. glabrosa* Srivastava, *G. tuberculata* Srivastava, *G. sidhiensis* Srivastava, *G. ovata* Srivastava, *Equitatilepis elongatus* Pant & Basu, *Satsangia campanulata* Srivastava & Maheshwari, *Conites* sp., *Chakrea papillata* Srivastava, *Rugaspermum insigne* Pant & Basu, *R. media* Pant & Basu, *R. obscura* Pant & Basu. Megaspores, namely, *Grambastisporites, Srivastavaesporites, Trikonia, Mamillaespora* and *Nidhitriletes* show lycopsid alliance.

Banerji *et al.* (1976) have described plant impressions from adjacent sediments. These comprise *Glossopteris gopadensis, G.* sp. cf. *G. senii, G. taeniopteroides, Dicroidium* spp., *Taeniopteris* sp. cf. *T. glandulata*, scales and seeds. This assemblage is very similar to the one described from the carbonaceous beds. However, in this bed *Dicroidium* is not that frequent as in the carbonaceous beds and therefore, authors have opined that the former could be slightly older deposit. I strongly feel that the frequency of *Dicroidium* in impression bed is more or less the same. As regards the differentiation between compression and impression beds at Nidpur, that could be ascribed due to varying sedimentological milieu prevailing at Gopad River Section; relatively high energy sandy shales permitted preservation of impressions while low energy fluvial flat with intermittent restricted circulation resulted in deposition of carbonaceous shales with excellent compressions.

The Nidpur outcrop has an overwhelming presence of *Dicroidium*, a taxon considered to be an infallible indicator of a Triassic age. The consistent association of *Pteruchus* and *Dicroidium* documents a Triassic age for Nidpur deposits. *Dicroidium* did not survive with any degree of certainty beyond Rhaetic and that becomes quite apparent from floral assemblage of Parsora Formation, the upper limit of the Triassic in South Rewa Gondwana Basin.

Dicroidium appeared on the Gondwana Triassic scene with characteristic pinnate organization and often a forked rachis whereas in Permian floral regime no such plants were present, on the contrary, glossopterids have simple entire, smooth margined leaves. In Nidpur, *Dicroidium* fronds fairly large, usually bipinnate or pinnate bearing thick cuticles, are generally met, a feature frequent in early-Middle Triassic leaves. Forked rachides have not been found by me because it is not easy to find a main rachis forked as the fronds are large and commonly got broken (Archangelsky, 1968). From Nidpur, Professor D. D. Pant of Allahabad University, Allahabad, has got a big *Dicroidium* frond accompanied with several others, revealing forked primary rachis (Pers. comm.).

Besides, the scrutiny of *Dicroidium* spp. from all over Gondwanaland has shown that the percentage-frequency of bipinnate-pinnate leaves is higher than those of forked *Dicroidium* fronds (Retallack, 1977).

Moreover, the concerted view and intensive work of Townrow (1957), Bonetti (1966), Archangelsky (1968), Bose and Srivastava (1971) and Retallack (1977) have definitively elaborated the genus *Dicroidium* so that it could incorporate the allied varied leafy forms. Therefore, Maheshwari's (1976) comments regarding the identity of Nidpur dicroidia, evidently has got no relevance in taxonomic consequences in Dicroidium Flora. On the other hand, other floral associates, more especially, the fertile structures have also to be taken into consideration before one points out taxon's identity. Interestingly, Maheshwari (1976) has placed Nidpur beds in lithostratigraphical sequence (Table 1) ranging from upper part of Lower Triassic-Middle Triassic. In view of the facts, the questioning of Venkatachala (1986) regarding the Nidpur dicroidia being the typical ones, is not considered valid.

Further, to equate the genus *Dicroidium* with those of *Buriadia* and *Botrychiopsis* (Venkatachala, 1986) is not at all tenable because the later two genera are neither widely distributed in the entire Gondwanaland nor they span throughout the Permian period. Therefore, they may not be taken as criterion for distinguishing a major sub-division.

Beside the taxa cited above, another significant constituent is *Lepidopteris* (though certain species such as *L. ottonis* and *L. martinsii* are known in Permian, see Vakhrameev *et al.*, 1978) which frequently occurs in Nidpur and because of its wide distribution in Triassic sediments of southern and northern hemisphere; having its dominance (inclusive of its fertile organs) in Triassic period, much reliance could be placed upon its presence too, as an indicator of age.

Palynoflora

Chandra and Satsangi (1965) first recorded the palynofloral assemblage from *Dicroidium*-bearing Nidpur Shale. Bharadwaj and Srivastava (1969) established taxonomically for the first time the broad Triassic miofloral frame work from Nidpur. Further, it would be worth to mention over here that these two palynofloras are from the same stratigraphic level of a condensed sequence and not the different expressions of the same assemblage as has been pointed out by Roychowdhury *et al.* (1975).

The palynoflora shows the preponderance of non-striate bisaccate pollen which constitute more than 50 per cent of the assemblage (Bharadwaj, 1970) and are presumed to be derived from *Dicroidium* (Anderson & Anderson, 1970; Roychowdhury *et al.*, 1975). Other pollen such as striate forms are little in quantity while costate and colpate ones are less frequent. Trilete spores are rare. Among the non-striate bisaccate grains, viz., *Satsangisaccites, Alisporites* and *Nidipollenites* occur in enormous number. The other important constituents, viz, *Weylandites* and *Praecolpatites* are also fairly represented in palynofloral assemblage. Trilete forms, although present, are quantitatively insignificant. *Satsangisaccites* distinguishes the Nidpur palynoflora from other miofloral assemblages.

The association of some pollen genera, namely, *Klausipollenites* and *Chordasporites* along with *Alisporites indicus* within a sporangium has been interpreted to represent ontogenetic stages of the same taxon (Srivastava, 1974c) because a relatively consistent sequential pattern is evident in *Alisporites* complex. *Alisporites indicus* which is of corystospermaceous origin, and extremely abundant in Middle-Upper Triassic units, could be treated as to be of potential stratigraphic significance. *Nidipollenites* was first recorded from Nidpur but now its occurrence has been noted in other Triassic assemblages of the Indian sub-continent such as Janar Nala, Upper Pali Formation of South Rewa Basin. Certain other newly evolved palynofossils such as *Weylandites* and *Praecolpatites* also occur in the flora. The striate bisaccate forms, viz., *Striatites, Lunatisporites, Striatopodocarpites, Faunipollenites*, etc. are represented in small quantities in Nidpur in comparison to Raniganj and Panchet mioflora. Of the typical elements of the Panchet mioflora, there is total absence of *Verrucosisporites, Decisporis* and *Playfordiaspora*, however, *Lunatisporites* by its occurrence in Nidpur assemblage, is long ranging. The conspicuous absence of *Playfordiaspora* particularly in Nidpur, is quite interesting because its range has been noted up to Norian (Tiki Formation). Thus on the basis of palynological succession, it may be inferred that the Panchet mioflora presents an older aspect than Nidpur mioflora and represents a transition between the two well-diversified miofloras of Raniganj and Nidpur; also it demonstrates that Nidpur is younger than Panchet Formation, thus supporting the megafloristic evidence in affixing the age of Nidpur beds.

STRATIGRAPHIC POSITION AND AGE

The floral contents of Nidpur have played pivotal role in determining the age and stratigraphic position of these beds in the Gondwana System of India.

Satsangi (1964) deduced that *Dicroidium*-bearing beds of Gopad River Section are certainly

not older than Panchet. Further, in the presence of variety of *Dicroidium* spp., Nidpur beds come closer to Parsora because of which author attributed the beds to be of younger aspect within the Panchet. Srivastava (1969), Bharadwaj and Srivastava (1969), Bose and Srivastava (1970), Srivastava (1971), Bose and Srivastava (1971, 1972) also envisaged Triassic age for Nidpur beds.

Bose (1974) considered Nidpur beds to be youngest amongst the Lower Triassic beds because of the absence of filicinean remains. Srivastava (1974a) concluded that the fossil assemblage is closer to Middle Triassic floras of the southern hemisphere and therefore younger than the Panchet Stage. Roychowdhury *et al.* (1975, table 13.2) supported this view and placed Nidpur beds at the base of Tiki Formation (Anisian). Mitra *et al.* (1979) too, have favoured Nidpur floral remains ranging in age from Upper Scythian-Lower Anisian. But because of the occurrence of this floral deposits in the vicinity of Raniganj Formation in nearby Singrauli Coalfield, authors have remarked that Raniganj-Panchet model loses its perfection in Damodar Valley and places Raniganj straddling across the so-called Permo-Triassic boundary. However, this hypothesis could not have weight owing to the recent finds of Raja Rao (1983) which show the occurrence of Panchet Formation in Latazharia, Harauri nalas and Gopad River Section. And with this report it is quite apparent that there is distinctive differentiation between the two formations (i.e., Raniganj & Panchet) and so, the question does not arise of Raniganj Formation extending beyond Permian. However, Raja Rao (1983) has placed Nidpur beds under Panchet Formation and also fully agrees with Srivastava's (1979) conclusion regarding Nidpur's stratigraphic position between Panchet and Parsora formations.

Biostratigraphically, Retallack (1977) recognized four zones based upon lineage of *Dicroidium*-leaves and considered Nidpur a transitional assemblage of Early Triassic and so, included floral assemblage in upper part of *Thinnfeldia callipteroides* Zone.

A Triassic age was ascribed to Nidpur outcrop (Chandra & Satsangi, 1965) because of the presence of enormous number of bi-winged gymnosperm pollen. Bharadwaj and Srivastava (1969) considered these beds to be of younger Lower Triassic (Panchet Stage) due to dominance of nonstriated-saccate and richness of *Dicroidium*.

Trivedi and Misra (1970) described a spore-pollen assemblage dominated by striate-bisaccate pollen from sediments near Nidpur and considered this deposit to be of Triassic age. But Srivastava (1974b) placed this palynoflora in Permian because of the total lack of *Dicroidium* leaves and other notable palaeofloral elements of *Dicroidium*-beds of Nidpur. Roychowdhury *et al.* (1975) were also of the same view and ruled out the possibility that two miofloras (Bharadwaj & Srivastava, 1969; Trivedi & Misra, 1970) are different expressions of same. Later, Banerji and Maheshwari (1974, 1975) and Pant and Pant (1987) also supported Srivastava's (1974) view for the age of the miofloral assemblage.

After this definitive Triassic palynofloral investigation of Nidpur, Panchet palynoflora could readily be differentiated from Nidpur palynoflora, because the palynofloral assemblage from Nidpur is characterized by virtual non-existence of triletes and preponderance of various kinds of gymnospermous pollen grains (Bharadwaj, 1970). The author placed Nidpur assemblage in Upper Panchet and pointed out that the palynoflora from Nidpur is fairly distinct from Lower Panchet and Upper Raniganj stages. This miofloral demarcation contradicts the view of Balme (1969) that Dicroidium Flora did not become firmly established until late Lower Triassic. However, Balme (1970) while dealing with palynology of Permian and Triassic strata in Salt Range, Pakistan, assigned late Early Triassic age to Nidpur beds because of the profuse occurrence of costate form *Weylandites*. But abruptly in the conclusion and comparative account of various Permian-Triassic assemblages he considered Nidpur palynoassemblage to be Late Permian.

Also Anderson and Anderson (1970) reviewed closely the palynoflora from Nidpur and considered it comparable with that from Lower Panchet (Chart 19; and in 1980, fig. 3), that is, from *Faunipollenites* (=*Protohaploxypinus reticulatus*) Zone in the lower most Narrabeen Group of Sydney Basin, Australia (dated as Late Permian, Helby, 1973; Balme & Helby, 1973). However, in Nidpur as the frequency of *Faunipollenites* is quite low and quantitatively insignificant, its comparison with lowermost Narrabeen Group does not appear to be justified.

Srivastava (1974b) while reviewing Triassic miofloristics of India, assigned Nidpur beds within Panchet Stage. Maheshwari (1974a, 1974b) expressed similar view for the placement of Nidpur beds with the rocks of Panchet Group. Banerji and Maheshwari (1974), Maheshwari and Banerji (1975) and Banerji and Maheshwari (1975) differentiated Nidpur palynoflora from miofloral assemblages of Maitur Formation and because of the paucity of striate bisaccate grains opined that Nidpur beds are definitely younger than Panchet Group. Bharadwaj and Tiwari (1977) while studying Permian-Triassic transition in Raniganj Coalfield, have also opined Nidpur mioflora to be younger than that of Panchet.

But Venkatachala (1978) contemplated Nidpur palynoassemblage to be a continuation of Raniganj palynoflora. However, the systematic analysis has

shown, within reason, that the transition from Permian to Triassic was a gradual one with a number of palynomorphs persisting relatively unchanged into the Triassic. Striated-bisaccate form is one such example. Although these forms are represented in small quantities, yet they reflect a wider range for the plant taxa which might have borne them. These forms continued from Raniganj through Panchet where their frequency was quite high, into Nidpur. Thus, Nidpur flora was composed of residual Palaeozoic taxa in association with characteristic forms of Triassic and newer types evolved. This gradual appearance of new elements reflects towards the advancing and developing nature of vegetation.

However, now it is quite apparent that the non-striate bisaccate grains attained potential value during Triassic and corroborate megafloristic evidence and show that gymnosperms were the main constituents of Nidpur vegetation except for occasional intrusion of Late Permian plant *Glossopteris* and re-emergence of some lower plant group. Now since the chief palynofossils of Nidpur that is *Nidipollenites, Satsangisaccites, Weylandites, Praecolpatites, Platysaccus queenslandii, Alisporites indicus* and *Aumancisporites* have attained stratigraphic significance, henceforth, to ascribe an Upper Permian age to Nidpur beds without presenting any reason is not justified.

Further, Maheshwari and Kumaran (1979), Kumaran and Maheshwari (1980) while dealing with the sporae-dispersae of Son River Section (Giar) and Janar Nala Section (Harai) have expressed their view that the time gap between Pali and Tiki Formation (=Anisian-Early Carnian) is probably represented by Nidpur beds which have been taken as representing the lower part of Tiki Formation (Roychowdhury *et al.*, 1975). They also brought Janar Nala (Harai) palynoflora much closer to Nidpur palynoflora by showing dominance of *Satsangisaccites* in both the assemblages because the later is distinguished by its occurrence in the assemblage and rest other palynomorphs of Nidpur are represented in Janar Nala in varying composition. But *Weylandites*, a striate-colpate taxon which is fairly frequent in Nidpur is conspicuously absent in Janar Nala assemblage.

Upon the palynologic zonation Sundaram *et al.* (1979) have grouped Nidpur beds under Middle Triassic (Table 2). They supported Roychowdhury *et al.* (1975) and have ruled out the possibility of Nidpur being younger than Middle Triassic. But from palynological stand point, Tiwari and Rana (1980) by equating *Goubinispora* with that of *Trochosporites* (*Trochosporites* sp. reported from Nidpur by Bharadwaj & Srivastava, 1969) showed the occurrence of this miospore genus in Nidpur palynoflora as well in bore-hole of East Raniganj. They also pointed out that *Goubinispora* represents a declining phase at Nidpur whereas in Middle Triassic palynofloral assemblage recovered from bore-hole, the palynotaxon was quite prolific. With this observation they dated Nidpur at younger level than Anisian, i.e., Carnian (early Late Triassic) and further reasoned out that Nidpur mioflora reveals no continuity with late-Early Triassic assemblage.

Sarbadhikari (1974, 1979) maintained the view that Nidpur belongs to Lower Panchet, to the *Glossopteris-Dicroidium* transitional Zone because its lithology does not match with the parent horizon (Panchet) where carbonaceous bands are practically unknown. Therefore, the author safely concluded that Nidpur *Dicroidium* since are preserved in carbonaceous shale might well be in uppermost Permian and thus was sceptical for the post-Raniganj status for Nidpur and consequently, correlated Nidpur *Dicroidium* with the occurrence of *Dicroidium* in the lowermost Narrabeen-strata of Australia.

However, findings of carbonaceous matter in Triassic sediments of Nidpur is not all new because similar floral assemblages preserved in carbonaceous shale have been reported from Triassic deposits of Gondwana countries. Further, Nidpur flora is full of *Dicroidium* leaves associated with its fertile organs and documents a wide spread in Upper Scythian-Anisian-Ladinian units. At Nidpur *Glossopteris* is in dwindling stage because the species met are reduced in number, size and shape and are in a very fragmentary state. Thus the continuity of *Glossopteris* in low frequency at Nidpur points out that the genus is long ranging and thereby loses its stratigraphical significance.

This could be further proven by another line of evidence like palaeoclimatic conditions which reveal that the relatively better Triassic floral assemblages occur in late Early to Middle Triassic (Late Scythian-Anisian-Ladinian) because of Permian climatic conditions which must have lingered on into the Triassic; similar conditions must have been prevailing in Nidpur (Lele, 1976) for the luxuriant growth of plants.

CONCLUDING REMARKS

Mega- and palyno- floral data from Nidpur are complementary and largely compatible. The synthesis of available data and comparative account with other Triassic floras known from India and other Gondwana continents reflect that in its qualitative or quantitative composition, Nidpur fossil flora does not fully agree either with the floral assemblage of Panchet Formation dominated by

Glossopteris or with the Upper Tiki and Parsora formations exhibiting Late Mesozoic plants *Pterophyllum, Elatocladus, Pagiophyllum* and *Desmiophyllum*. However, Nidpur palaeofloral assemblage differs substantially in richness of *Dicroidium* and pollen genera, chiefly *Nidipollenites, Satsangisaccites, Alisporites* and *Weylandites* as compared to other Triassic formations of India. But these genera so characteristic of Nidpur are also well represented in Middle-Upper Triassic floras of Gondwana countries.

Unequivocally, with the balanced floristic picture provided by megaplant studies, stratigraphic position of Nidpur beds between that of Panchet and Parsora Formation is favoured and a Middle Triassic age (=Anisian-Ladinian) is supported.

REFERENCES

Anderson, H. M. & Anderson, J. M. 1970. A preliminary review of the biostratigraphy of the uppermost Permian, Triassic and lowermost Jurassic of Gondwanaland. *Palaeont. Afr.* **13** : 1-22.

Anderson, J. M. 1980. World Permo-Triassic correlations: their biostratigraphic basis. *in* : Campbell, K. S. W.(Ed.)—*Gondwana Five.* Wellington, New Zealand, pp. 3-10.

Archangelsky, S. 1968. Studies on Triassic fossil plants from Argentina-1. The leaf genus *Dicroidium* and its possible relation to *Rhexoxylon. Paleontology* **11** : 500-512.

Balme, B. E. 1969. The Permian-Triassic boundry in Australia. *Spec. Publ. Geol. Soc. Australia* (2) : 99-112.

Balme, B. E. 1970. Palynology of the Permian and Triassic strata in the Salt Range and Surghar Range, West Pakistan. *in* : Kummel, B. & Teichert, C. (eds)—*Stratigraphic boundary problems,* Univ. Kansas Geol. Dept. Spec. Publ. **4** : 305-453.

Balme, B. E. & Helby, R. 1973. Floral modifications at the Permian-Triassic boundry in Australia, *in* : Logan, A. & Hills, L. V. (eds)—*The Permian and Triassic systems and their mutual boundry.* Mem. Can. Soc. Pet. Geol. **2** 433-444.

Banerji, J., Kumaran K. P. N. & Maheshwari, H. K. 1978. Upper Triassic Spoare-dispersae from the Tiki Formation: mega spores from the Janar Nala Section, South Rewa Gondwana Basin. *Palaeobotanist* **25** : 1-26.

Banerji, J. & Maheshwari, H. K. 1974. Palynology of the Panchet Group exposed in the Nonia Nala, near Asansol, West Bengal. *Palaeobotanist* **21** : 368-372.

Banerji, J. & Maheshwari, H. K. 1975. Palynomorphs from the Panchet Group exposed in Sukri River, Auranga Coalfield, Bihar. *Palaeobotanist* **22** : 158-170.

Banerji, J., Maheshwari, H. K. & Bose, M. N. 1976. Some plant fossils from the Gopad River Section near Nidpur, Sidhi District, Madhya Pradesh. *Palaeobotanist* **23** : 59-71.

Bharadwaj, D. C. & Srivastava, Shyam C. 1969. A Triassic mioflora from India. *Palaeontographica* **B125** : 119-149.

Bharadwaj, D. C. 1970. Sporological dating of non-marine sedimentary rocks in India. *J. Palaeont. Soc. India* **15** : 15.

Bharadwaj, D. C. & Tiwari, R. S. 1977 Permian-Triassic miofloras from the Raniganj Coalfield, India. *Palaeobotanist* **24** : 26-49.

Bonetti, M. I. R. 1966. Considerations sobre algunos representated de la familia "Corystospermaceae." *Ameghiniana* **4** : 389 395.

Bose, M. N. 1974. Triassic floras. *in* : Surange, K. R. *et al* (eds)—*Aspects and appraisal of Indian palaeobotany,* Birbal Sahni Institute of Palaeobotany, Lucknow : 258-293.

Bose, M. N. & Srivastava, Shyam C. 1970. *Glottolepis rigosa* gen. et sp. nov. from Triassic beds of Nidpur. *Palaeobotanist* **18** : 215-217

Bose, M. N. & Srivastava, Shyam C. 1971. The genus *Dicroidium* from the Triassic of Nidpur, Madhya Pradesh, India. *Palaeobotanist* **19** : 41-51.

Bose, M. N. & Srivastava, Shyam C. 1972. *Lepidopteris indica* sp. nov. from the Lower Triassic of Nidpur, Madhya Pradesh. *J. palaeont. Soc. India* **15** : 64-68.

Bose, M. N. & Srivastava, Shyam C. 1973a. *Nidistrobus* gen. nov., a pollen bearing fructification from the Lower Triassic of Gopad River Valley, Nidpur *Geophytology* **2** : 211-212.

Bose, M. N. & Srivastava, Shyam C. 1973b. Some micro and megastrobili from the Lower Triassic of Gopad River Valley, Nidpur. *Geophytology* **3** : 69-80.

Chandra, A. & Satsangi, P. P. 1965. Microflora from the *Dicroidium* bearing beds of Sidhi District, Madhya Pradesh. *Curr. Sci.* **34** : 459-460.

Helby, R. 1973. Review of Late Permian and Triassic palynology. *N.S.W. Spl. Publ. Geol. Soc. Australia* : 141-155.

Hughes, T. W. H. 1881. Notes on the South Rewa Gondwana Basin. *Rec. geol. Surv. India* **14**(1) : 126-138.

Kumaran, K. P. N. & Maheshwari, H. K. 1980. Upper Triassic Sporae-dispersae from the Tiki Formation, 2: miospore from the Janar Nala Section, South Rewa Gondwana Basin, India. *Palaeontographica* **B173** : 26-84.

Lele, K. M. 1976. Palaeoclimatic implications of Gondwana floras. *Geophytology* **6** : 207-229.

Maheshwari, H. K. 1974a. Raniganj-Panchet Boundry. *in* : Surange, K. R. *et al.* (eds)—*Aspects and appraisal of Indian palaeobotany,* Birbal Sahni Institute of Palaeobotany, Lucknow, pp. 408-420.

Maheshwari, H. K. 1974. Triassic miofloras South of the Tethys. *1st Indian palynol. Cong., Chandigarh* : 236-244.

Maheshwari, H. K. 1976. Floristics of the Permian and Triassic Gondwanas of India. *Palaeobotanist* **23** 145-160.

Maheshwari, H. K. & Banerji, J. 1975. Lower Triassic palynomorphs from the Maitur Formation, West Bengal, India. *Palaeontographica* **B152** : 149-190.

Maheshwari, H. K. & Kumaran, K. P. N. 1979. Upper Triassic Sporae-dispersae from the Tiki Formation—1: miospores from the Son River Section between Tharipathar and Ghiar, South Rewa Gondwana Basin. *Palaeontographica* **B171** : 137-164.

Maheshwari, H. K., Kumaran, K. P. N. & Bose, M. N. 1978. The age of the Tiki Formation: with remarks on the miofloral succession in the Triassic Gondwanas of India. *Palaeobotanist* **25** : 254-265.

Mitra, N. D., Bose, U. & Dutta, P. K. 1979. The problems of classification of the Gondwana Succession of the peninsular India. *IV int. Gondw. Symp., Calcutta* **2** : 463-469.

Pant, D. D. & Basu, N. 1973. *Pteruchus indicus* sp. nov. from the Triassic of Nidpur, India. *Palaeontographica* **B144** : 11-24.

Pant, D. D. & Basu, N. 1977 On some seeds, synangia and scales from the Triassic of Nidpur, India. *Palaeontographica* **B163** : 162-178.

Pant, D. D. & Basu, N. 1978. On two structurally preserved bryophytes from the Triassic of Nidpur, India. *Palaeobotanist* **25** : 340-352.

Pant, D. D. & Basu, N. 1979. Some further remains of fructifications from the Triassic of Nidpur, India. *Palaeontographica* **B168** : 129-146.

Pant, D. D. & Basu, N. 1979. On some megaspores from the Triassic of Nidpur, India. *Rev. Palaeobot. Palynol.* **28** : 203-221.

Pant, D. D. & Basu, N. 1981. Further contributions on the non-vascular cryptogams from the Middle Gondwana (Triassic)

beds of Nidpuri, India—Part II. *Palaeobotanist* **28-29** : 188-200.

Pant, D. D. & Pant, R. 1987. Some *Glossopteris* leaves from Indian Triassic beds. *Palaeontographica* **B205** : 165-178.

Raja Rao, C. S. 1983. Coalfields of India—Singrauli Coalfield. *Bull. geol. Surv. India* **45** : 130-193.

Retallack, G. 1977. Triassic vegetation: microfische supplement, University of New England, Geology Deptt. Armidalos. *N.S.W. Microfische frames* : G1-J-16.

Retallack, G. 1977. Reconstructing Triassic vegetation of eastern Australia, a new approach for the biostratigraphy of Gondwanaland. *Alcheringa* **1** : 247-277.

Roychowdhury, M. K., Sastry, M. A. V., Shah, S. C., Singh, G. & Shah, S. C. 1975. Triassic floral succession in the Gondwana of Peninsular India. *in* : Campbell, K.S. W. (Ed)—*Gondwana Geology, 3rd int. Gondw. Symp., Canberra* : 149-158.

Sarbadhikari, T. R. 1974. The limits of stratigraphic distribution of *Glossopteris* in India. *Rev. Palaeobot. Palynol.* **18** : 29-307.

Sarbadhikari, T. R. 1979. Some problems of the Triassic Gondwanas of India. *IV int. Gondw. Symp., Calcutta* **2** : 470-477. Hindustan Publ. Corp., Delhi.

Srivastava, Shyam C. 1969. Two new species of *Glossopteris* from the Triassic of Nidpur, Madhya Pradesh, India. *in* : Santapau H. *et al.* (eds)—*J. Sen Memorial Volume*, Bot. Soc. Bengal, pp. 229-303.

Srivastava, Shyam C. 1971. Some gymnospermic remains from the Triassic of Nidpur, Sidhi District, M. P. *Palaeobotanist* **18** : 280-296.

Srivastava, Shyam C. 1974a. Floristic evidence on the age of Gondwana beds near Nidpur, Sidhi District, M. P. *Palaeobotanist* **2** : 193-210.

Srivastava, Shyam C. 1974b. Triassic mioflora, *in* : Surange K. R. *et al.* (eds)—*Aspects and appraisal of Indian palaeobotany*, Birbal Sahni Institute of Palaeobotany, Lucknow, pp. 224-298.

Srivastava, Shyam C. 1974c. Pteridospermic remains from the Triassic of Nidpur, M. P., India. *Geophytology* **4** : 54-59.

Srivastava, Shyam C. 1975a. *Pteruchus indicus* sp. nov. from the Triassic of Nidpur, M. P. *Sci. Cult.* **41** : 211-212.

Srivastava, Shyam C. 1975b. A new microsporangiate fructification from the Triassic of Nidpur, India. *Palaeobotanist* **22** : 19-22.

Srivastava, Shyam C. 1976. Some macroplant-fossils from the Triassic rocks of Nidpur, India. *Palaeobotanist* **23** : 44-48.

Srivastava, Shyam C. 1977 Some species of the genus *Glottolepis* Bose & Srivastava from the Triassic of Nidpur, India. *Palaeobotanist* **23** : 223-230.

Srivastava, Shyam C. 1979. The Triassic flora of Nidpur, India. *in*: Laskar, B. & Raja Rao, C. S. (eds)—*IV int. Gondwana Symp., Calcutta Papers* **2** : 105-108. Hindustan Publ. Corp., Delhi.

Srivastava, Shyam C. 1984a. *Sidhiphyllites*: a new ginkgophytic leaf genus from the Triassic of Nidpur, India. *Palaeobotanist* **32** : 20-25.

Srivastava, Shyam C. 1984a. *Lelestrobus*: a new microsporangiate organ from the Triassic of Nidpur, India. *Palaeobotanist* **32** : 86-90.

Srivastava, Shyam C. 1984c. New leaf compressions from the Triassic of Nidpur, India. *Geophytology* **14** : 199-207.

Srivastava, Shyam C. & Maheshwari, H. K. 1973. *Satsangia*: a new plant organ from the Triassic of Nidpur, M. P. *Geophytology* **3** : 222-227.

Sundaram, D., Maiti, A. & Singh, G. 1979. Upper Triassic mioflora from Tiki Formation of South Rewa Gondwana Basin, Madhya Pradesh, India. *in*: Laskar, B. & Raja Rao, C. S. (eds)—*IV. int. Gondwana Symp., Calcutta Papers* **2** : 511-514. Hindustan Publ. Corp., Delhi.

Tiwari, R. S. & Rana, V. 1980. A Middle Triassic mioflora from India. *Biol. Mem.* **5** : 30-55.

Trivedi, B. S. & Misra, J. P. 1970. Triassic miospore assemblage from Nidpur, district Sidhi, M. P. *J. palaeont. Soc. India* **14** : 14-27.

Townrow, J. A. 1957. On *Dicroidium*, probably a pteridospermous leaf and other leaves now removed from this genus. *Trans. geol. Soc. S. Afr.* **60** : 21-56.

Townrow, J. A. 1958. Two Triassic bryophytes from South Africa. *J.S. Afr. Bot.* **25** : 1-22.

Vakhrameev, V. A., Dobruskina, E. A., Zaklinskaya, E. D. & Meyen, S. V. 1970. Palaeozoic and Mesozoic floras of Eurasia and phytogeography of this time. *Acad. Sci. U.S.S.R. Trans.* **208** (in Russian).

Venkatachala, B. S. 1978. Palynological stratigraphy and exploration of fossil fuels. *Presidential Address—Division III. Proc. IV int. palynol. Conf., Lucknow* **1** : 22-43. Birbal Sahni Institute of Palaeobotany, Lucknow.

Venkatachala, B. S. 1986. Palaeobotany in India—Quo vadis? *Geophytology* **16** : 1-24.