FLORISTIC EVIDENCE ON THE AGE OF GONDWANA BEDS NEAR NIDPUR, SIDHI DISTRICT, MADHYA PRADESH*

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ABSTRACT

On the evidence of mega- and microfossils, the fossiliferous beds at Nidpur are considered to be of Triassic age. The various Triassic mega- and microfloral assemblages from southern hemisphere have been compared with the floral assemblage of Nidpur. Floristically, the age of Nidpur fossiliferous bed is younger than the Panchet Stage. The most characteristic feature of the Nidpur flora is the overwhelming dominance of the genus *Dicroidium*.

INTRODUCTION

THE earliest survey of plant bearing rocks from the Gopad River Valley in Sidhi District, M. P. was made by Hughes (1881). So far, from this general area only mega- and microplant fossils of Raniganj affinities were known (Feistmantel, 1882; Ahmad, 1953; Ahmad & Rao, 1954 in Krishnan, 1958 and Maheshwari, 1967). But Satsangi's (1964) discovery of *Dicroidium* bearing beds in Gopad river cutting, near Nidpur, has revealed the presence of Triassic sediments too in the Gondwana succession of Gopad valley.

MEGAFLORA OF NIDPUR

In the Triassic formations of India (summarized below), as far as the cuticular study is concerned the fossil flora of Nidpur is, so far, the best known. This is because at Nidpur most of the plants are preserved in the form incrustations while at other Triassic localities the plants are present either as impressions or in the form of ferruginous crust. Because of this indifferent mode of preservation, surface structure of a few species of *Dicroidium* has been studied under transmitted light from the Parsora Stage of South Rewa Gondwana Basin. The details of cuticular structure are not known in other Indian Triassic plants. In addition to the mode of preservation, in the Triassic of India, the species are very poorly represented as shown in the table below.

Recently, the detailed and illustrative palaeobotanical work of Nidpur megaplant fossils has been done by Srivastava (1969, 1971, 1974a,b) Bose & Srifvastava (1970, 1971, 1972, 1973a,b) and Srivastava & Maheswari (1973). The Triassic flora of Nidpur is characterized by the overwhelming dominance of the genus *Dicroidium*

Standard Scale	Gondwana	Division	Damodar Valley	Auranga Valley	Son Valley	Satpura Basin	Pranhita Godavari Valley
Rhaetic	Mahadeva Series	Maleri	—	—	Tiki	Bagra Denwa	Maleri
—	—	Pachmarhi	—	—	—	Pachmarhi	—
Keuper-Muschelkalk	—	Parsora	—	—	Chichariya Parsora	—	—
Bunter	Panehet	—	—	—	Nidpur	—	—
—	Series	Panchet	Panchet	Deobar	Daigaon, Ramkola-Tattapani (Karamdiha, Ledho nala)	Almod	Mangli

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Gothan. There are three species of *Dicroidium* and out of these *D. nidpurensis* Bose & Srivastava and *D. papillosum* Bose & Srivastava are the commonest. At places the whole fossiliferous bed is almost made up of these two species. The third species, viz., *D. gopadensis* Bose & Srivastava is rather rare. Along with the specimens of *Dicroidium*, a single specimen of *Lepidopteris* (*L. indica*) Bose & Srivastava has also shown its presence in these beds. Besides *Dicroidium*, the genus *Glossopteris* Sternberg is also fairly well represented by distinct species, viz., *G. senii* Srivastava, *G. papillosa* Srivastava, *G. nidpurensis* Srivastava, *G.* Sp. A, *G*, sp. B., *G.* sp. and *G.* sp. cf. *G. linearis*. The Glossopteridales also comprises the genus *Rhabdotaenia* Pant but this genus is very rare at Nidpur. The specimens are extremely fragmentary so they have been described as *Rhabdotaenia* sp. The other genera present are *Taeniopteris* Brongniart (*T. glandulata* Srivastava), *Noeggerathiopsis* sp., *Conites* sp. and a new genus *Glottolepis rugosa* Bose & Srivastava. Out of these, *T. glandulata* is present in fairly good number. *Noeggerathiopsis* and *Conites* are very fragmentary and poorly represented in the assemblage whereas *Glottolepis rugosa* Bose & Srivastava is quite common. In addition to these genera, three fragmentary conifer shoots have also been described. Recently some pollen and seed-bearing strobili have been described as *Nidistrobus harrisianus* Bose & Srivastava and *Nidia ovalis* Bose & Srivastava. Besides these, a new genus *Satsangia* (*S. Campanulata*) Srivastava & Maheshwari has also been instituted for some fructification-like bell shaped plant organs. Along with these a new species of *Pteruchus* (Thomas) Townrow (*P. nidpurensis* Srivastava) has also been discovered. But amongst all these fertile organs *N. harrisianus* occurs most abundantly in these beds.

MIOFLORA OF NIDPUR

Miofloristically, the Triassic beds in India have been only scantily surveyed. A few publications on the mioflora of extra-peninsular Triassic are also available. From peninsular India, the Triassic mioflora of Nidpur, has been described by Bharadwaj and Srivastava (1969) in detail and about this, Chandra and Satsangi (1965) had already made a preliminary report.

The mioflora of Nidpur is represented by one each of the trilete and monolete genera, 17 genera of saccate pollen grains, 2 genera of non-saccate pollen grains and one genus of preacolpate pollen grains. Bisaccate gymnospermous pollen grains occur fairly in abundance in this assemblage whereas representatives of trilete and monolete spores occur very rarely.

The miofloral assemblage is constituted by the genera, *Laevigatosporites, Densipollenites, Platysaccus, Nidipollenites, Striatites, Verticipollenites, Lahirites, Lunatisporites, Striatopodocarpites, Faunipollenites, Chordasporites, Distriatites, Satsangisaccites, Sulcatisporites, Klausipollenites, Alisporites, Trochosporites, Weylandites, Aumancisporites* and *Praecolpatites. Punctatisporites* and *Taeniaesporites* have not been encountered in counting. Out of these, 4 genera (*Nidipollenites* Bharadwaj & Srivastava, *Satsangisaccites* Bharadwaj & Srivastava, *Weylandites* Bharadwaj & Srivastava and *Praecolpatites* Bharadwaj & Srivastava) have been newly erected. Besides these new genera, 18 new species, viz., *Densipollenites densus, Nidipollenites monoletus, Striatites sidhiensis, Lunatisporites gopadensis, Striatopodocarpites nidpurensis, Faunipollenites gopadensis, Satsangisaccites nidpurensis, S. triassicus, Sulcatisporites triassicus, S. royii, Alisporites indicus, Weylandites indicus, W. circularis, W. minutus, W. bilateralis, W. irregularis, Aumancisporites indicus* and *Praecolpatites nidpurensis* have also been reported by Bharadwaj and Srivastava (1969) from this assemblage.

As a whole the miofloral assemblage is dominated by non-striate bisaccate grains and the genus *Satsangisaccites* is the most dominating element in Nidpur mioflora.

MEGAFLORISTIC COMPARISON

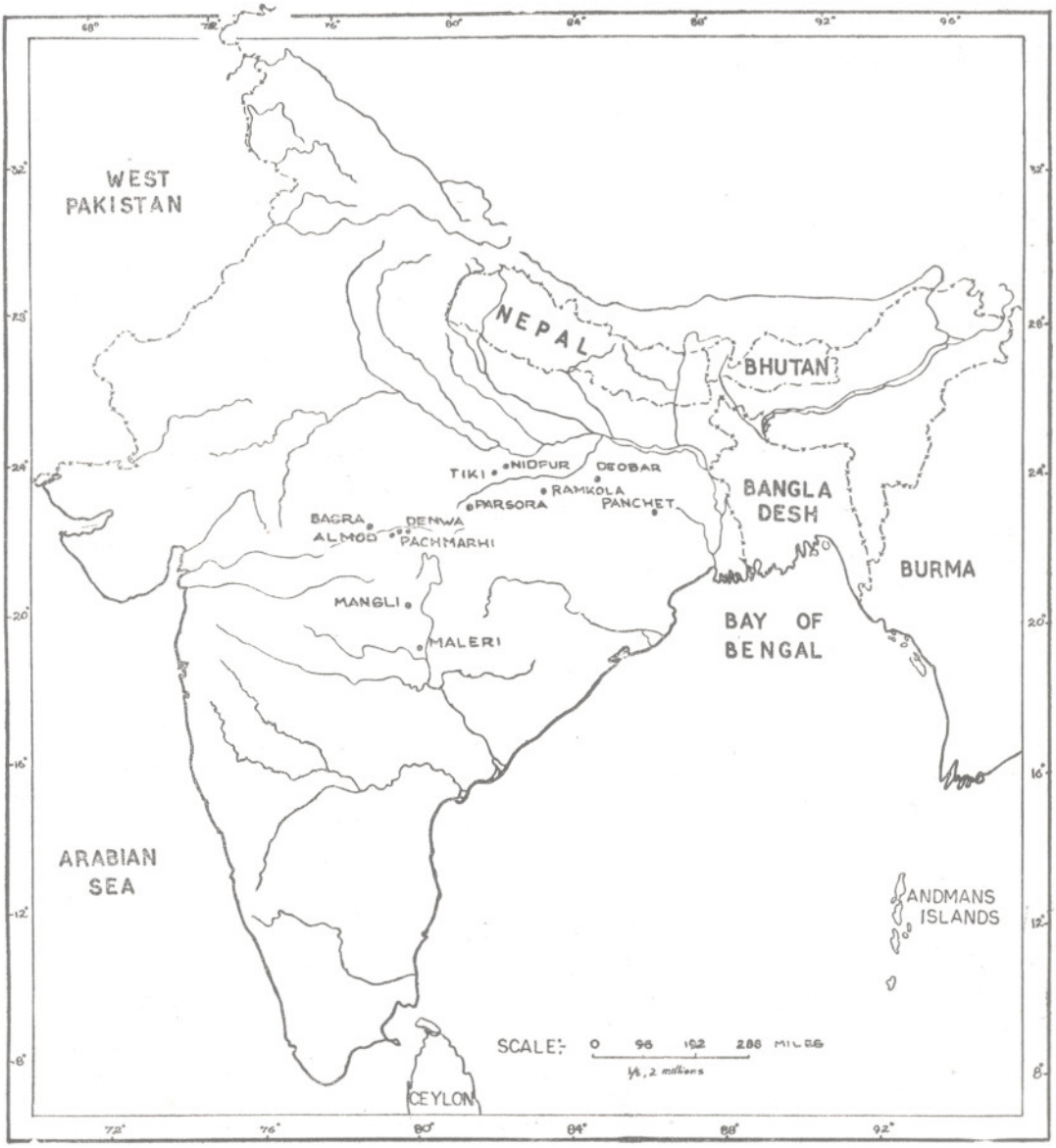
The relation of megascopic flora of Nidpur to Triassic floras of extra- and peninsular India has been discussed here in detail. The floral assemblage has also been compared with some of the Triassic floras known from Gondwanaland countries viz. Australia, Tasmania, New Zealand, Madagascar, Africa, Argentina, Brazil, Chile and Antarctica.

PENINSULAR INDIA

Amongst the known Triassic formations of India (Map 1) the fossil floras of Panchet and Parsora are well diversified.

The Lower Triassic flora from Panchet formations of Raniganj coalfield was described by Feistmantel (1881), Ghosh and Mitra (1970) and Satsangi (1971).

The floral assemblage comprises *Schizoneura gondwanensis* Feistmantel, *Vertebraria indica* Royle, *Pecopteris concinna* Presl, *Cyclopteris pachyrhachis* Göeppert, *Taeniopteris* sp. cf. *T. stenoneuron*, *Glossopteris indica* Schimper, *G. communis* Feistmantel, *G. angustifolia* Brongniart, ?*Dicrcidium* sp., *Podozamites* and *Samaropsis* ?sp. Göeppert. Out of these *S. gondwanensis* and *G. communis* are the commonest. *S. gondwanensis* is so far not known from Nidpur and so is *G. communis*. However, in external characters *G. papillosa* Srivastava resembles very much *G. communis*. Since the *Dicroidium* reported by Satsangi (1971)



Map 1.

is a doubtful form and also not followed by any description or figure, hence, it is difficult to say whether they are pinnate, bipinnate or they have forked rachis.

None of the remaining species, viz., *Pecopteris concinna, Cyclopteris pachyrhachis, Glossopteris indica, G. browniana* and *Samaropsis* sp. are so far known from Nidpur. So except for the presence of *Dicroidium*-like leaves and species of *Glossopteris* the Panchet flora seems to be quite distinct from the Nidpur floral assemblage. Even the genus *Dicroidium* which is so common at Nidpur, is very rare in the Panchet Assemblage.

Floral assemblage from Deobar, Auranga Valley Coalfield described by Bhattacharya (1963) is characterized by the frequent presence of *Dicroidium sahnii* (Seward) Rao & Lele along with *Schizoneura, Glossopteris, Vertebraria, Rhabdotaenia* and *Samaropsis*. Because of the lithological similarity and the presence of *Dicroidium*, Deobar beds exposed in the vicinity of Auranga river are considered to be Lower Triassic in age. *Dicroidium* specimens from Deobar are known in small bits and they are pinnate. Pinnae (?pinnules) are very small as compared to the pinnules of the various species of *Dicroidium* from Nidpur. Almost all the species of *Glossopteris* known from the Deobar are similar to the Raniganj form whereas from the Nidpur all the species are new on the basis of cuticular features.

Lower Triassic flora of Ramkola and Tattapani area from Madhya Pradesh was first recorded by Griesbach (1880) and later megafossils were described in detail by Feistmantel (1881). The megafloral constituents are: *Glossopteris indica* Schimper, *G. angustifolia* Brongniart, *G. communis* and *Dicroidium odontopteroides* (Morris) Gothan. When Ramkola and Tattapani floral assemblage is compared with Nidpur flora, it becomes quite evident that both the floras agree only in having two common floral constituents namely, *Glossopteris* and *Dicroidium* and rest of Nidpur plant fossils are absent from Ramkola area. From the other Lower Trissic formations, viz., Almod beds (Satpura Basin) recognized by Medlicott (1873) and Mangli beds (Pranhita-Godavari valley) named by Hughes (1877), comparison with Nidpur flora could not be made because these beds have not yielded recognizable plant remains. These beds are known to belong to Triassic either on the basis of lithology or palaeontology.

The Parsora Stage (Middle-Upper Triassic) is represented by quite a few genera and species which are not known from Nidpur. The flora from Parsora Stage in detail has been described by Feistmantel (1882), Cotter (1917), Seward (1932), Saksena (1962), Lele (1953, 1955, 1961a, 1961b, 1962, 1969), Rao & Lele (1960, 1962), Vimal & Singh (1968) and Rao (1954; in Krishnan, (1958), Rao & Shukla (1954; in Krishnan 1958). *Lycopodites sahnii* Lele, *Schizoneura gondwanensis* Feistmantel, *Neocalamites foxii* Lele, *Marattiopsis* sp. *Danaeopsis gracillis* Lele, *Cladophlebis* sp. and *Sphenopteris polymorpha* Feistmantel, belonging to the Pteriodophyta are completely missing at Nidpur. Among the gymnosperms, described from the various localities in the Parsora Stage, *Pseudoctenis* (*P. balli* (Lele), *Pterophyllum* (*P. sahnii* Lele & *P. karkatiensis* Vimal & Singh), *Baiera* (*B. indica* Lele), *Araucarites* (*A. parsorensis* Lele and *A. indica* Lele), *Desmiophyllum* (*D. indicum* Lele and *D. taeniatum* Lele), *Cordaicarpus* (*C. chichariensis* Lele and *C. ovatus* Lele), *Samaropsis* (*S. srivastavi* Lele, *S. menisca* Lele and *S. surangei* Lele) and a new genus *Parsorophyllum indicum* Lele are also completely missing at Nidpur. The common genera are *Glossopteris, Dicroidium, Taeniopteris* and *Conites*. But among these genera none of the species is common to both Nidpur and Parsora Stage. The species of *Glossopteris* (*G. indica, G. communis, G. browniana* and *G. angustifolia* Feistmantel) occurring at various localities in the Parsora Stage are similar to those present in the Panchet. As for *Dicroidium*, they are no doubt, dominant, at most of the localities in the Parsora Stage but are not so abundant as the Nidpur *Dicroidium*. Also in the Parsora Stage *D. odontopteroides* is the most common species and next to this species is *D. hughesii* (Feistmantel) Townrow. Both these species are missing at Nidpur. In addition to these two species *D. sahnii* (Seward) Rao & Lele is also absent at Nidpur, Moreover, all these three species are having forked rachises unlike the Nidpur species which are bipinnate. In the Parsora Stage species of *Taeniopteris* (*T. spatulata* McCl.) are also quite different from the Nidpur species (*T. glandulata* Srivastava). So taking over all the assemblages in the Parsora Stage and at Nidpur, it is quite

evident that the constituents are quite distinct from each other. While in the Parsora Stage a few Jurassic elements, such as *Pseudoctenis, Pterophyllum, Araucarites* and *Desmiophyllum* are present, no such form is present at Nidpur.

The fossil flora from Pachmarhi Stage is meagrely known. The specimens reported by Crookshank (1936) are all fragmentary and indeterminable. So it is difficult to compare the Pachmarhi flora with the Nidpur flora. But recently, Wadia (1966, p. 193) listed a number of plant fossils without figuring or describing any one of them. Out of this list, *Dicroidium and Glossopteris* are in common in both the floral assemblages.

Like Pachmarhi flora the fossil plants from other Upper Triassic formations, viz., Tiki, Maleri, are very poorly known. These have been assigned an Upper Triassic age because of lithological and palaeontological evidences. Sahni (1931) described a piece of wood collected by Cotter (1917) from Tiki as *Mesembrioxylon malerianum*. Recently, Sahni and Rao (1956) also assigned these beds an Upper Triassic age because of the presence of *Dicroidium* and *Taeniopteris* near Ghiar.

From Maleri area near Naogaon some plant fossils have been recorded by Feistmantel (1877) and were described by Sahni (1931). The assemblage represents the characteristic Upper Jurassic and Lower Cretaceous elements, viz., *Araucarites cutchensis* Feistmantel and *Elatocladus jabalpurensis* (Feistmantel) Sahni. But none of these genera are present at Nidpur. Besides these plant fossils, Rao and Shah (1960) and Mahabale (1967) reported a mixed floral assemblage from Kota-Maleri beds, Adilabad District, Andhra Pradesh. The floral assemblage comprises *Schizoneura, Neocalamites, Glossopteris, Noeggerathiopsis, Dicroidium odontopteroides* and *D. hughesii* along with a few cycadophytes and conifers. Out of these genera *Glossopteris, Noeggerathiopsis* and *Dicroidium* are the common floral constituents in both the assemblages.

Since the Upper Triassic beds, viz., Bagra and Denwa (Medlicott, 1873) completely lack the plant remains, therefore, no comparison is possible with Nidpur floral assemblage.

EXTRA-PENINSULAR INDIA

Sitholey (1943) first described the Triassic flora from extra-peninsular deposit of Salt Range, Punjab and the floral assemblage comprises the genera *Equisetites, Sphenopteris, Cladophlebis,* and *Indotheca,* the first pteridospermous microsporophyll from India. Nidpur flora is not comparable to this Salt Range Triassic assemblage and markedly contrasts in the overwhelming presence of *Dicroidium* and also in complete absence of pteridophytic remains.

AUSTRALIA

In Australian Triassic there are two distinct floras — one belonging to the Lower Triassic and the other to the Middle and Upper Triassic. Out of these, Nidpur floral assemblage compares most with the Lower Triassic of Narrabeen Stage Hawkesbury Series, New South Wales, Eastern Australia (see Tenison-Woods, 1883; Etheridge, 1894; Feistmantel, 1890; Dun, 1910, 1911; Walkom, 1925, 1932; Burges, 1935; Jacob & Jacob, 1950; Townrow, 1956, 1957, 1966, 1967, 1970; Helby & Martin 1965; Branagon, 1969; Ragatt, 1969; McElroy, 1969 and Lovering & McElroy, 1969). So far, from Narrabeen beds, *Lycostrobus, Phyllotheca australis, Sphenopteris, Schizoneura gondwanensis, Coniopteris* sp. of. *C. lobata, Cladophlebis* sp., *Calopteris, Todites, Hymenophyllites, Zeugophyllites, Glossopteris browniana, Lepidopteris madagascariensis, Dicroidium odontopteroides, D. feistmanteli, D. narrabeenensis, Taeniopteris tenisonwoodsii, T. crassinervis, T. triassica, T. wianamattae, Pterophyllum, Rissikia, Ginkgoites* sp. ?, *Rhipidopsis narrabeenensis, Phoenicopsis* ?, *Araucarites sydneyensis, Carpolithus* sp. and *Cyclostrobus* have been described. Among these *Glossopteris, Lepidopteris, Dicroidium* and *Taeniopteris* are common to both Nidpur and Narrabeen beds. *Glossopteris browniana* from Narrabeen beds resembles in external form the leaves of *G. papillosa* from Nidpur. In external and to some extent in cuticular structure the leaves of *D. feistmanteli* resembles very much the leaves of *G. nidpurensis* and *D. papillosum.* In general form and venation *Taeniopteris wianamattae* is very much like *Rhabdotaenia* sp. from Nidpur and also *Araucarites sydneyensis* resembles very much *Conites* sp. described from Nidpur in external form.

The other Lower Triassic flora described by Chapman and Cookson (1927) and

Douglas (1969) from Bald hill, Bacchus Marsh, Victoria has *Phyllotheca australis, Schizoneura microphylla, Coniopteris delicatula, D. odontopteroides, Taeniopteris wianamattae, Ginkgoites digitata, Baiera darlevensis* and some other doubtful forms. Among these, *Dicroidium feistmanteli* resembles most the species of *Dicroidium* described from Nidpur.

The Middle and Upper Triassic floras from Queensland, Australia, are quite distinct from the Nidpur flora because in them quite a few Rhaetic or Jurassic elements are present along with *Schizoneura, Glossopteris, Taeniopteris* and *Dicroidium*. In the Ipswich Series near Brisbane, Queensland (see Etherdgie Jr., 1889; Jack & Etheridge Jr., 1892; Shirley, 1898, 1902; Antevs; 1913; Walkom, 1915, 1917, 1918, 1921; Jones, 1948, 1949; Jones & deJersey, 1947; Jacob & Jacob, 1950; Townrow, 1957, 1960, 1966, Phillips, *et al.*, 1960; White, 1965, 1966, 1969, in Anderson & Anderson, 1970; Hill *et al.*, 1965), *Stenopteris, Doratophyllum, Ctenis* and *Czeknowskia* have been described. None of these Rhaetic and Jurassic plants are known from Nidpur. In addition to these, *Yabeilla* and *Fraxinopsis* the well known Upper Triassic forms are also known from Ipswich Series.

The fossil flora from Esk Series, too is quite distinct from the Nidpur assemblage (see Walkom, 1924, 1928 and Hill, 1930). This flora resembles more the flora from Parsora Stage in having *Schizoneura, Neocalamites, Sphenopteris, Pseudoctenis, Pterophyllum* and *Baiera*.

The Leigh Creek and Springfield assemblage from South Australia (see Chapman, 1926; Parkin, 1953 and Johnson, 1960) is also quite distinct from Nidpur assemblage in having *Schizoneura, Equisetites, Neocalamites, Cladophlebis, Stenopteris, Phyllopteris, Psygmophyllum, Frenelopsis, Podozamites* and *Araucarites*. Out of these, *D. feistmanteli*, resembles in external form *D. nidpurensis* and *D. papillosum* described from Nidpur.

TASMANIA

The Triassic flora from the Feldspathic Sandstone Series of Tasmania (see Walkom, 1924, 1925 and Townrow, 1957, 1959, 1965, 1966) and Townrow and Jones (1969) is supposed to be of Upper Triassic or Rhaetic in age. It is characterized by the presence of *Hepaticites, Muscites, Phyllotheca, Neocalamites, Cladophlebis, Sphenopteris Pecopteris, Linguifolium, Dicroidium, Pachypteris, Pteruchus, Pseudoctenis, Pterophyllum, Ginkgoites* and *Baiera*. None of these genera are present at Nidpur except *Dicroidium* and *Pteruchus*.

NEW ZEALAND

Triassic-Rhaetic flora of New Zealand from Mount Potts, Clent Hills, District Canterbury and from Hokonuii Hills South Land, described by Arber (1907, 1909, 1913a, 1913b, 1917) is also quite distinct from the Nidpur assemblage in having *Phyllotheca, Chiropteris, Cladophlebis, Sphenopteris, Coniopteris, Dictyophyllum, Linguifolium, Elatocladus* and *Baiera*. The only common genera are *Dicroidium* and *Taeniopteris*. Somewhat similar flora from Black Jacks Waitaki river, South Canterbury of New Zealand has been described by Bell, Harrington and Mckellar (1956). Unlike Nidpur assemblage it has *Cladophlebis, Chiropteris, Callipteridium, Linguifolium* and *Carpolithus*.

MADAGASCAR

Nidpur floral assemblage resembles somewhat the Lower Triassic flora of Madagascar as described by Zeiller (1911), Carpentier (1935, 1936), Besairie (1960) and Townrow (1966). The common genera are *Glossopteris, Lepidopteris, Dicroidium, Noeggerathiopsis* and *Taeniopteris*. At Madagascar *Cladophlebis, Danaeopsis, Buriadia heterophylla, Voltzia* and *Carpolithus* are known to occur, but these genera are absent at Nidpur.

SOUTH AFRICA

In South Africa the Triassic formations are met within the Beaufort and Stormberg series. Both these series range in age from Lower to Middle-Upper Triassic. The fossil flora from the Beaufort Series as described by Dujoit (1927) and Townrow (1956, 1957) consists of *Equisetites, Schizoneura, Neocalamites, Odontopteris, Glossopteris, Lepidopteris, Dicroidium, Taeniopteris, Nilssonia. Pterophyllum, Strobilites* and

Ginkgoites. Out of these genera common to Nidpur assemblage are *Glossopteris, Lepidopteris, Dicroidium* and *Taeniopteris*. But among these genera none of the species are common to each other.

The Stormberg Series having the Molteno beds of Natal (Umkomass and Burnera Waterfall localities) described by Feistmantel (1889), Seward (1908), Du Toit (1927, 1932), Thomas (1933), Townrow (1956, 1957, 1960, 1962, 1967b) and Fabre & Greber (1960) has yielded one of the richest Triassic flora in the southern hemisphere. Besides *Glossopteris, Lepidopteris, Dicroidium, Pteruchus* and *Taeniopteris* which are present at Nidpur, the Molteno beds also have *Equisetites, Schizoneura, Neocalamites, Marattiopsis, Cladophlebis, Sphenopteris, Dictyophyllum, Pachypteris, Stenopteris, Stormbergia, Antevsia Peltaspermum, Pilophorosperma, Umkomassia, Spermatocodon, Pseudoctenis, Chiropteris, Pterophyllum, Zamites, Moltenia, Dadoxylon, Rhexoxylon Elatocladus, Voltzia, Strobilites, Rissikia, Conites, Ginkgoites, Baiera* and *Stachyopitys*. So this assemblage has also some common Jurassic elements such as Zamites and *Elatocladus*.

In Cape Colony the Mesozoic strata has also the Stormberg Series besides the Jurassic of Utenhage Series. The Stormberg Series has been described by Seward (1903, 1911) from Maclear, Tina river, Kenigha river, Materiale, Molteno and Stormberg. The assemblage comprises *Schizoneura, Neuropteridium, Cladophlebis, Glossopteris, Lepidopteris, Dicroidium, Stenopteris, Taeniopteris, Chiropteris, Strobilites, Phoenicopsis Baiera* and *Stachyopitys*. Out of these only *Lepidopteris, Dicroidium* and *Taeniopteris* are common to both Nidpur and Stormberg Series of Cape Colony.

Fossil flora of Somabula beds, Southern Rhodesia (Upper Triassic), described by Seward and Holttum (1921) and Walton (1923, 1926, 1929) is also comparable to some extent to Nidpur assemblage in the presence of abundance of *Dicroidium* and *Taeniopteris* but the former assemblage may be differentiated from the latter assemblage in having *Schizoneura, Pachypteris, Dadoxylon, Rhexoxylon* and *Cyparissidium*.

The fossil flora described by Seward (1922, 1934) from Msimbasi river, Tanzania (Tanganyika) is quite different from the Nidpur flora and it is supposed to be of Upper Triassic or Rhaetic in age. The assemblage consists of *Baiera, Cupressinocladus, Desmiophyllum* and *Voltziopsis*.

Recently, from the vicinity of Tanga, East Africa (Lower Triassic), Townrow (1967) has described *Voltziopsis africana*. This genus is so far not known from Nidpur.

SOUTH AMERICA

The Triassic flora of Argentina from South America has been worked out by various authors in fairly great detail. Most of the plants described are from Middle to Upper Triassic beds. Our knowledge of the Triassic flora from South America is based mainly on the work of Geinitz (1876), Szanocha (1888, 1889, 1891), Hauthal (1892), Kurtz (1921), Gothan (1925), Fossa-Mancini (1937), Frenguelli (1941a, 1941b, 1943a, 1943b, 1942, 1944a, 1944b, 1944c, 1944d, 1946, 1947, 1948, 1950), Archangelsky (1963, 1968), Archangelsky & Brett (1960, 1961, & 1963), Sota & Archangelsky (1962), Menendez (1951a,b, 1956, 1957), Stipanicic and Menéndez (1949), Gröeber & Stipanicic (1952), Stipanicic (1956, 1967), Stipanicic & Bonetti (1965, and 1967), Stipanicic *et al.*, 1968), Mésigos & Stipanicic (1967), Bonetti (1963, 1966a,b, 1968a,b), Herbst (1963), Bonetti & Herbst (1966), Jain & Delevoryas (1967), Brett (1968) and Yrigoyen (1967).

In Argentina the Triassic flora is known from Cerro de la Cabras (Upper Carnian), Estrato de Barreal (Upper Carnian), Estrato de Potrerillos (?Norian), Estrato de Cacheuta (Upper Norian) and Estrato de Ischigualasto (Upper Norian). The floral assemblage of Cerro de la Cabras (see Frenguelli, 1948 and Gröeber & Stipanicic, 1952) differs markedly from the Nidpur assemblage in having *Nilssonia, Desmiophyllum* and *Elatocladus*. Estrato de Barreal (see Frenguelli, 1944; Stipanicic & Menèndez, 1949; Bonetti, 1963, Stipanicic & Bonetti, 1965, 1966) assemblage is much diversified and differs from Nidpur assemblage in having *Equisetites, Neocalamites, Coniopteris, Thaumatiopteris, Xylopteris, Dicroidiopsis, Diplasiophyllum, Saportaea, Pseudoctenis, Chiropteris, Pterophyllum* and *Baiera*. The Cacheuta formation (see Frenguelli, 1941, 1942, 1943, 1944; Townrow, 1957, 1962; Jain & Delevoryas, 1967) too has a very rich floral assemblage associated with index genus *Dicroidium*. It has a large

number of genera which are entirely missing at Nidpur, viz., *Phyllotheca, Equisetites, Neocalamites, Cladophlebis, Xylopteris, Yabeilla, Dicroidiposis, Diplasiophyllum, Umkomassia, Ginkgoites, Baiera, Sphenobaiera, Ginkgodium, Baierophyllites, Czekanowskia, Cycadocarpidium, Phoenicopsis, Podozamites, Fanerotheca, Chancitheca* and *Fraxinopsis*. Here, too, none of the species are common to both the assemblages. In the Ischigualasto formation (see Frenguelli, 1944 and Bonetti, 1966) the only genus which is also present at Nidpur is *Dicroidium*. But none of the species resemble each other. This has a large number of genera which are completely absent at Nidpur. They are *Phyllotheca, Equisetites, Neocalamites, Dicroidiopsis, Lepidanthium, Cardiopteridium, Elatocladus* and *Cycadocarpidium*.

BRAZIL

The Triassic flora described by Rau (1933), Dolianiti (1945), Gordon & Brown (1952), Barbosa (1953), Beltrão (1965) and Bortoluzzi & Barbeena (1967) from Brazil is meagrely known. These assemblages resemble Nidpur in the presence of *Dicroidium* in abundance. But the floral assemblages, apart from this similarity, are quite distinct from Nidpur in having *Schizoneura, Neocalamites, Sphenopteris, Samaropsis, Nilssonia, Pterophyllum, Otozamites, Cedroxylon, Sphenozamites* and ?*Podozamites*.

CHILE

Nidpur flora is also comparable to some extent to the Triassic assemblage of Chile described by Zeiller (1875), Solms-Laubach, Graf and Stainmann (1899), Fuenzalida (1937) and Nishida (1970) only in the presence of *Dicroidium*. The genera *Equisetites, Pecopteris, Lyginodendron, Chiropteris Baiera, Czekanowskia* and *Araucarioxylon* are absent from Nidpur.

ANTARCTICA

The Triassic fossil flora of Antarctica recorded by Plumstead (1962), Gunn and Warren (1962), Townrow (1967) and Rigby and Schopf (1969) shows similarity with the Nidpur assemblage in having the common elements, viz., *Glossopteris, Dicroidium, Taeniopteris* and *Noeggerathiopsis* but the Antarctican flora differs from Nidpur in the presence of *Schizoneura, Neocalamites, Vertebraria, Zylopteris* cf. *Diplasiophyllum* and cf. *Johnstonia trilobita, Phoenicopsis* and *Czekanowskia*.

MIOFLORISTIC COMPARISON

A comparison similar to megascopic flora has been carried out with regard to the Nidpur mioflora, though with attention paid to genera rather than species.

From a comparative study of the Nidpur mioflora with Gopad bridge miospore assemblage of Raniganj Stage (Maheshwari, 1967), it becomes apparent that the two agree in the presence of genera, namely, *Densipollenites, Platysaccus, Striatites, Lahirites, Lunatisporites, Striatopodocarpites, Verticipollenites, Faunipollenites, Sulcatisporites* qualitatively but not quantitatively. As against this similarity, Nidpur assemblage shows a clear distinction from it too, in having forms like *Nidipollenites, Distriatites, Chordasporites, Satsangisaccites, Klausipollenites, Alisporites, Trochosporites, Weylandites, Aumanciporites* and *Praecolpatites* and in lacking the typical genera of Raniganj Stage. Quantitatively, in Gopad bridge assemblage the genera *Densipollenites, Striatites, Striatopodocarpites, Faunipollenites, Lahirites, Cuneatisporites* and *Sulcatisporites* are dominating, whereas in Nidpur assemblage, *Nidipollenites, Satsangisaccites, Alisporites* and *Weylandites* occur in abundance.

Comparing Nidpur spore assemblage with Raniganj mioflora from the type locality (Bharadwaj, 1966), it has been observed that although some characteristic elements of Raniganj Stage, e.g. *Lunatisporites, Striatites, Faunipollenites are present* in Nidpur mioflora, there is virtually a complete lack of complementary trilete forms. As compared to the mioflora of Damuda Series as a whole, some genera which occur as important components of Nidpur assemblage seem to have appeared earlier but only as very rare components (refer. Bharadwaj & Srivastava, 1969).

PENINSULAR INDIA

The miofloral assemblage of Nidpur has been compared briefly to its older and younger miofloras of India along with

meagrely known Lower Triassic miofloral assemblages of Peninsular India.

Recently a miospore assemblage described by Trivedi and Misra (1970) from Gopad river area near Nidpur has been considered by the authors to be of Triassic age because of dominance of striate bisaccate grains and variety of trilete spores. But the miofloral assemblage (Trivedi & Misra, 1970) shows affinity towards Upper Permian because of presence of typical miospores of Raniganj Stage, e.g. *Lophotriletes, Acanthotriletes, Distriomonosaccites, Striomonosaccites, Striatopodocarpites, Faunipollenites, Striatites, Lunatisporites, Verticipollenites, Sulcatisporites* and *Cuneatisporites*. Besides these genera, a few striate forms, e.g. *Granulostriatites, Gopadstriatites, Traveculosporites,* have been newly erected by Trivedi and Misra (1970) but in any case these new genera are not much different from *Striatopodocarpites* and *Striasulcites* Venkatachala & Kar. Likewise, *Lattisosporites* is exactly similar to *Weylandites*, Bharadwaj & Srivastava (1969). Nidpur flora markedly differs from the floral assemblage of Trivedi and Misra (1970) in the presence of *Nidipollenites* and *Satsangisaccites* but simultaneously it comes closer from the latter in the presence of striated bisaccate grains qualitatively. Quantitatively its presence is insignificant. Hence, on the basis of miofloristic evidence, it seems quite reasonable to place these beds of Trivedi and Misra (1970) along with Permian strata. In addition to this it can be further stated that the Permian sediments (Raniganj Stage) are exposed in Gopad river cutting in very close proximity of the Nidpur Triassic strata (refer. Bharadwaj & Srivastava, 1969).

Lately, the mioflora of early Panchet which overlies the Raniganj Stage has been described by Srivastava and Pawde (1962) and briefly reported by Satsangi *et al.* (1968, 1972). These assemblages lack the characteristic miospores of Raniganj Stage as well as those of Nidpur mioflora. Recently, a detailed work of Kar (1970) from a bore-core in Raniganj coalfield which belongs to Panchet Series has revealed that Panchet miofloral assemblage is dominated by trilete spores, i.e. *Biretisporites, Dictyophyllidites, Baculatisporites, Osmundacidites, Divaripunctites, Subverrusporis, Decisporis, Discisporites, Rimaspora* and *Granuloperculatipollis*. This assemblage too lacks the characteristic miospores of Raniganj as well as of Nidpur. Further it is apparent that as compared to Nidpur assemblage, the mioflora of Panchet Stage is richer in pteridophytic spores and thereby it is closer to the mioflora of Raniganj Stage than Nidpur assemblage is to the latter. This Panchet mioflora appears to be poorer in the number of spore genera as compared to that of Raniganj Stage as well as Nidpur assemblage.

The Jurassic miofloras of India when compared with Nidpur assemblage, reveal that only *Alisporites* and *Platysaccus* are the common constituents and the rest of the genera are completely absent from Nidpur.

EXTRA-PENINSULAR INDIA

Miofloristically, Triassic exposures of extra-peninsular India are represented by two formations, namely, Krol Series and Salt Range, Punjab (the latter now in Pakistan).

Sitholey (1943) first recovered mega- and microspores from Sakesar, Salt Range, Punjab and he provisionally referred the larger spores under the genus *Triletes* species and the smaller spores under the genus *Sporites*. Also the author mentioned the presence of disc-like bodies, spore cast and bivalved structures. Later, Pant (1949) and Pant and Srivastava (1964) from the same sample described the maga- and miospores, viz., *Zeillerisporites, Triletes Talchirella, Punctatisporites, Lophotriletes, Perisaccus* and *Pityosporites*. Recently, a rich mioflora described by Balme (1970) from Lower to Middle Triassic of Salt Range comprises the genera *Punctatisporites, Calamospora, Cyclogranisporites, Verrucosisporites, Osmundacidites, Simenospora, Tigrisporites, Nevesisporites, Perotriletes, Kraeuselisporites, Densoisporites, Lundbladispora, Guthoerlisporites, Aratrisporites, Cordaitina, Taeniaesporites, Guttulapollenites, Vitreisporites, Klausipollenites, Falcisporites, Alisporites, Sulcatisporites, Platysaccus, Fimbraesporites, Ephedripites, Cycadopites* and *Schizosporis*. Thus it is quite obvious that the Triassic miofloral assemblage of Salt Range is dominated by trilete form. When Nidpur mioflora is compared with the miofloral assemblages of Salt Range, it is found that the bisaccate genera *Platysaccus queenslandii, Klausipol-*

lenites, Alisporites and *Sulcatisporites* are common to both and other genera, e.g. *Vitreisporites, Falcisporites* and *Cycadopites* are completely missing. *Taeniaesporites* is present in abundance in the Triassic of Salt Range but in Nidpur, this genus has been reported only on the basis of one or two grains. Also in Salt Range, none of the typical Triassic miospores of Nidpur is present. It is also noteworthy that Triassic of Salt Range completely lacks the striated bisaccate grains.

The mioflora from Krol series near Nainital was discovered by Sitholey *et al.* (1954) and in later years Lakhanpal, *et al.* (1958) and Sah *et al.* (1968) in the light of recent studies recognized the following genera, viz., *Calamospora, Planisporites, Dictyotriletes, Apiculatisporis, Laevigato sporites, Striatites, Lunatisporites, Stroter-sporites, Striatopodocarpites, Striatopiceites, Sulcatisporites, Cuneatisporites, Pityosporites, Succinctisporites, Alisporites, Triadispora, Platysaccus, Voltziaceaesporites* and cf. *Schizopollis*. Thus, Krol miofloral assemblage resembles Nidpur mioflora in having high frequency of non-striate bisaccate grains. However, miospores, viz., *Laevigatosporites, Striatites, Striatopodocarpites, Sulcatisporites, Alisporites* and *Platysaccus* are present in both the assemblages. Apart from this, another microfloral assemblage reported by Ghosh and Srivastava (1963) from the Mussorie Mule Track belonging to Krol Series could not be compared with the Nidpur mioflora because the authors have mentioned only a few spore types, e.g. triletes, monoletes, striated, disaccates and trisaccates.

AUSTRALIA

Hennelly (1958) investigated palynological fossils from the Permian-Triassic transition of New South Wales, Eastern Australia from a bore-core and attempted to demarcate the Permo-Triassic boundary distinctly by the abundance of striate bisaccates in the Upper Permian and the trilete spores in the lowermost Triassic. Contrary to this, Nidpur mioflora shows the majority of the nonstriate bisaccate grains.

Recently, Helby (1967, 1970) recovered Lower Triassic miofloral assemblages from Wollar Sandstone and Sydney Basin of New South Wales, Eastern Australia respectively. The assemblage is rich in pteridophytic spores and the frequency of striate disaccates and non-striate disaccate though present yet it is comparatively low. However, when it is compared with the Nidpur, it shows similarity in the presence of some of the miofloral elements, viz., *Striatopodocarpites, Lunatisporites, Sulcatisporites, Chordasporites, Klausi-pollenites, Alisporites, Aumancisporites* and *Praecolpatites*. But despite this closeness, the two assemblages can be distinguished fairly because Nidpur lacks almost all the trilete forms except *Punctatisporites* and also a few bisaccate and monocolpate grains. Also New South Wales mioflora shows complete absence of *Nidipollenites, Satsangisaccites* and *Weylandites*, the most characteristic forms of Nidpur.

Balme (1963, 1969a,b) studied the Lower Triassic miospores from the various basins, i.e. Perth, Canning and Canorvon of Western Australia and also tried to fix the Permian-Triassic boundary on the implications of palynological data. In all the localites his observation revealed that the triletes are dominated in the Lower Triassic while the underlying Permian assemblages are dominated by the striate disaccates. The trilete taxa described by him are, viz., *Kraeuselisporites* and *Lundbladispora*, the dominant miospores and rest have, however, been not recorded from India. *Taeniaesporites* is present in abundance while it is very poorly represented in Nidpur assemblage, *Platysaccus queenslandii* is common to both and *Aratrisporites* is missing in Nidpur.

DeJersey (1970) described early Triassic miospores from the Rewan Formation of Queensland which also reveals the dominance of trilete spores. Non-striate bisaccates are few in number. As far as Nidpur miofloral assemblage is concerned, it can be readily distinguished from the Rewan by presence of non-striate bisaccate grains in abundance. *Alisporites* is common to both.

As regards the Middle and Upper Triassic miofloras from various formations of Queensland, deJersey (1949, 1962, 1964, 1965, 1970a, 1970b, 1971a, b); deJersey & Hamilton (1965a, 1965b, 1965c, 1967, 1969); Evans (1964, 1966a, b & c); and Playford & Cornelius (1967) have made contributions of paramount importance.

Comparing Nidpur spores and pollen with the miofloras of Queensland Triassic, a close

similarity in general aspects is apparent. The important constituents between them are: *Satsangisaccites, Alisporites, Chordasporites, Sulcatisporites, Klausipollenites,* and *Platysaccus queenslandii* but Nidpur assemblage differs in the complete absence of the genera, *Calamospora, Verrucosisporites, Converrucosisporites, Cingulatisporites, Aratrisporites, Triadispora, Leiotriletes, Circulisporites Callialasporites, Dictyophyllidites, Pilasporites, Laricoidites, Granulatisporites, Stereisporites, Annulispora, Lycopodiumsporites, Osmundacidites, Foveosporites, Polycingulatisporites, Duplexisporites, Polypodiisporites, Tuberculatosporites, Partitisporites, Circulina, Discisporites, Cadargasporites, Rewanispora, Baculatisporites, Classopollis, Perinopollenites, Inaperturopollenites, Semiretisporites, Pustulatisporites, Guttatisporites, Tigrisporites, Rugulatisporites, Vitreisporites, Cycadopites, Araucariacites* and *Tenuisaccites.* Amongst all these trilete forms, only *Punctatisporites* is scantily represented in Nidpur but it shows its abundance in Queensland microflora.

A particularly, interesting and significant occurrence is that of the genus *Satsangisaccites* in the Rhaeto-Liassic of Leigh Creek Coal Measures of South Australia (Playford & Dettmann, 1965), which clearly indicates a long range for this genus. Besides this genus a few other common constituents are *Distriatites* (described by Playford & Dettmann as *Hamiapollenites*), *Alisporites, Platysaccus queenslandii, Punctatisporites* but this mioflora differs from Nidpur assemblage in the presence of *Apiculatisporis, Neoraistrickia, Ischyosporites, Foraminisporis, Guthoerlisporites, Lundbladispora, Punctatosporites* and *Aratrisporites* along with other Ipswich genera referred earlier.

TASMANIA

A comparison of Nidpur mioflora can also be made with the miospore assemblage of Late Triassic from Tasmania (Playford, 1965) in the common occurrence of genera like *Satsangisaccites, Alisporites, Platysaccus queenslandii, Taeniaesporites* and *Punctatisporites* but the latter differs by the presence of *Calamospora, Stereisporites, Concavisporites, Osmundacidites, Acanthotriletes, Apiculatisporis, Neoraistrickia, Tigrisporites, Annulispora, Krauselisporites, Baculatisporites, Nevesisporites, Lundbladispora, Densoispora, Circulisporites, Guthoerlisporites, Aratrisporites* and *Protohaploxypinus.*

MADAGASCAR

Jekhowsky and Goubin (1964) and Goubin (1965) have described Triassic miofloral assemblages from Madagascar which are comparable to Nidpur favourably in the presence of *Platysaccus, Sulcatisporites, Taeniaesporites* and *Alisporites.* But other forms like *Classopollis, Inaperturopollenites, Applanopsis, Podocarpidites, Cuneatisporites, Lueckisporites, Striomonosaccites, Strotersporites, Rimaesporites, Graminoides, Laricoidites, Vitreisporites, Protohaploxypinus, Falcisporites, Samaropollenites, Guttulapollenites, Vittatina* and *Cycadopites* are missing in Nidpur.

SOUTH AFRICA

Regarding Triassic mioflora of South Africa, no definite record is available so far. But recently, a few miospore types have been recognized in a tabular form from Molteno beds (Middle-Upper Triassic) (refer. Anderson & Anderson, 1970, p. 13). This table of miospore types reflect the dominance of trilete forms though associated with striate non-striate and alete forms. However, with this knowledge of Molteno mioflora, no comparison is possible with Nidpur.

SOUTH AMERICA

The first record of plant microfossils was made by Orlando (1954) from Cacheuta formations (Mendoza) of Argentinian Triassic. But the author did not give any systematic account of pollen and spores, The microfloral components were described as *Pteruchus, Monocolpites, Zonatognites, Antholithus* and *Oedemosaccus.* Only *Alisporites* type of grains from Nidpur can be closely compared with the *Pteruchus* grain of Cacheuta formations.

The miospore assemblage from Minas de Petroleo beds of Cacheuta Formation (Middle Triassic), from Argentina described by Jain (1968), is dominated by non-striate bisaccates (46-50%) and monocolpate (24%) pollen grains. The alete forms are also copious (23%) while pteridophytic spores and striate saccates are rare (1% each). As compared to Nidpur assemblage, it lacks

Satsangisaccites, Nidipollenites, Weylandites and *Praecolpatites,* all the characteristic genera of the former. In over all nature this Argentinian assemblage has more pronounced Cycado-Ginkgoalean character as compared to Nidpur mioflora. Nidpur mioflora also compares a little in the presence of *Klausipollenites* cf. *K. staplinii, Alisporites* and *Punctatisporites* from that of Ischigualasto beds (Upper Triassic) of Argentina described by Herbst (1965) but the latter differs in the presence of trilete forms, e.g. *Cingulatisporites, Clavatriletes, Discisporites, Planisporites, Verrucosisporites Discisporites, Planisporites, Verrucosisporites* and other monocolpate genera, viz., *Cycadopites, Entylissa, Lagenella, Monosulcites* and *Gemmamonocolpites.*

ANTARCTICA

It is also worthwhile to compare Nidpur mioflora with spore assemblage described by Norris (1965) and Helby and McElroy (1969) from Middle-Upper Triassic beds of Antarctica. The assemblage is rich in pteridophytic spores associated with a few non-striate bisaccate grains, viz., *Alisporites* and *Vitreisporites. Alisporites* is a dominant constituent of Antarctican flora and in Nidpur too, this genus is represented fairly in abundance. Other forms, namely, *Converrucosisporites, Dictyophyllidites, Neoraistrickia, Nevesisporites, Osmundacidites, Polypodiisporites, Punctatosporites, Protohaploxypinus, Quadrisporites, Verrucosisporites, Cadargasporites* and *Aratrisporites* are completely missing from Nidpur.

CONCLUDING REMARKS

A perusal of foregoing comparative accounts reveal that megafloristically, Nidpur assemblage corresponds more to the Lower Triassic flora of southern hemisphere. The assemblage resembles most the assemblage from the Panchet Stage of India, Narrabeen Stage of Australia, Upper Beaufort beds of South Africa, Triassic deposits of Madagascar and Antarctica. But, in the overwhelming dominance of genus *Dicroidium,* Nidpur megaflora comes more closer to the Middle Triassic floras of Gondwana continents.

Miofloristically, Nidpur assemblage depicts closest qualitative agreement with the mioflora of Raniganj Stage (Upper Permian) of India which it overlies. However, with the latter it differs substantially in the quantitative composition of some pollen genera, chiefly, *Nidipollenites, Satsangisaccites, Alisporites* and *Weylandites* all of which are absent in the underlying mioflora from Gopad bridge. The early Panchet mioflora from Raniganj coalfield which is dominated by trilete forms, presents an older aspect as compared to the Nidpur flora and represents the transition between two well diversified miofloras of Raniganj Stage and Nidpur. The genera *Satsangisaccites* and *Alisporites* so characteristic of Nidpur are also well represented in the Middle Triassic miofloras of Australia. While in Australian assemblages *Satsangisaccites* and *Alisporites* are associated with non-Permian spore genera, in the Nidpur assemblage they are associated with Permian spore genera. Evidently, the Nidpur shales are younger than the Permian and older than the Upper Triassic.

Thus, in terms of Indian stratigraphical sub-divisions, on the basis of mega- and miofloristic evidences, Nidpur beds can be surmized to lie in the Panchet Series. However, the richness of *Dicroidium* as compared to *Glossopteris* in the Nidpur shales ascribes a younger aspect to it than the Panchet Stage.

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