PALYNOSTRATIGRAPHICAL STUDIES OF CARBONACEOUS SHALES FROM KOTRI, NARSINGHPUR DISTRICT, M. P., INDIA*

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ABSTRACT

The present paper deals with the palynostratigraphy of carbonaceous shales from Satpura coal basin, exposed on Sapan Nala at Kotri near Chindkhera village, in Narsinghpur District, Madhya Pradesh, India. The miofloral assemblage consists of 31 miospore genera and 71 species.

Quantitatively the mioflora shows the prominence of coniferalean elements viz., *Callialasporites dampieri* and *Araucariacites jabalpurensis*. Pteridophytic and cycadales miospores are poor in the assemlage. A comparative account of the mioflora indicates closeness with the Bottom palynozone of Upper Katrol, Assemblage—A of Bansa, Lower beds of Lameta Ghat and Microflora IIa from W. Australia. Hence, it could be an older unit in Jabalpur Series.

INTRODUCTION

The present paper deals with the palynostratigraphy of the carbonaceous facies, deposited at Kotri near Chindkhera village. The outcrop lies in the Chaugan Reserved forest in the Narsinghpur District, Madhya Pradesh, India. CROOKSHANK (1936) observed that red Denwa clays are interbedded with the Jabalpur carbonaceous shales at Chindkhera, but generally as a rule Bagras and Denwas unconformably underlie the Jabalpurs in the hills capping the Narbada plain. Many palaeobotanists such as FEISTMANTEL (1877); BOSE (1959, 1960, 1966) BOSE AND DEV (1959), BOSE AND MAHESHWARI (1973) recorded many fossil plant remains from the carbonaceous sediments from Sehora in Narsinghpur District. Some of them are *Cladophlebis*, *Todites*, *Onychiopsis*, *Pachypteris*, *Doratophyllum*, *Ptiolophyllum*, *Williamsonia*, *Bucklandia*, *Coniferocaulon*, *Brachyphyllum*, *Pagiophyllum* and *Araucarites*, etc. SHRIVASTAVA (1954), DEV (1961), SINGH (1966), BHARADWAJ *et al.*, (1972) and KUMAR (1973) studied the palynoflora from Narsinghpur and Jabalpur Districts.

MATERIAL AND METHODS

The coal and associated carbonaceous shale samples from Satpura Gondwana basin were collected by us in the year 1976. The outcrop was exposed at Kotri in Sapan nala, about 4 kms north of Chindkhera village (22°39′ : 78°56′) in the Chaugan Reserved forest, Narsinghpur District. Alternate bands of sandstone and carbonaceous shale with coaly partings were exposed in the nala. Six fresh samples were taken out from the well cleaned exposed surface. They were carefully sealed and packed into polythene bags for the laboratory processes. These samples were got registered from the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow. The lithological details of the section are given in Table 1.

For the recovery of spores and pollen grains from the sediments, about 10-20 gms of each sample were crushed and treated with about 40 per cent Hydrofluoric acid overnight

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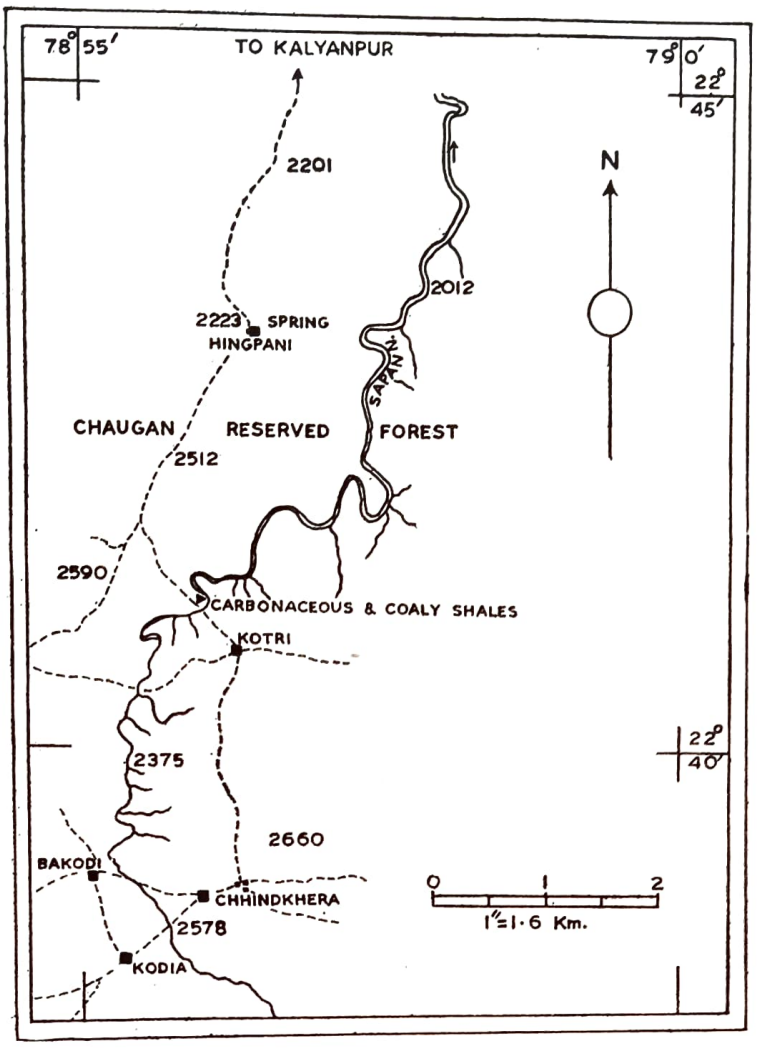


Map 1. Showing the section exposed at Kotri.

Table 1—Kotri-Section exposed in Sapan nala about 4 kms north of Chindkhera village (Map-1)

Sl. no.	Regd. Sample No.	Lithological Description	Thickness
1.	..	Top sandstone—Pink coloured fine grained showing current bedding	About 250 ft
2.	1763/6	Coaly shale	1ft
3.	1763/5	Carbonaceous shale, finely laminated	2½ ft.
4.	..	Sandstone	4ft
5.	1763/4	Coaly shale	1/2ft
6.	1763/3	Carbonaceous shale	4 ft
7.	..	Sandstone	5ft
8.	1763/2	Coaly shale	2 ft
9.	1763/1	Carbonaceous shale	6ft
10.	..	Bottom sandstone bearing pot holes, thickness not measurable	

to remove siliceous matter. Later on, this material was repeatedly washed and then put into commercial Nitric acid for about a week or so till the oxidation was completed. The material was again washed off repeatedly to get the acid free residue which was finally reacted with 10 per cent KOH solution and warm it up to simmering temperature so as to dissolve the humic substances, washed off and sieved it with a 300 mesh standard sieve. This macerate-was kept in glycerine jelly for preparing the slides for the study of spores and pollen grains.

PALYNOLOGICAL COMPOSITION

Qualitatively, the miofloral assemblage from Kotri consists of 31 miospore genera and 71 species. Among them, 15 are trilete, 3 monoletes, one hilate, one monosaccate, 7 bisaccates, one polysaccate, one monocolpate, one alete nonsaccate and one operculate nonsaccate. A few striated bisaccate pollen grains are also present in the assemblage. The miospores which have been identified are given in the following list :

Cyathidites australis Couper
C. minor Couper
C. densus Kumar
C. cf. *C. concavus* (Bolkhov.) Dettm.
Haradisporites mineri Singh & Kumar
H. scabratus Kumar
Concavisporites novicus Kumar
Todisporites major Coup.
T. minor Coup.
Concavissimisporites sp.
Osmundacidites wellmanii Coup.
Klukisporites haradensis Kumar
Cicatricosisporites sp.
Matonisporites dubius Kumar
Matonisporites sp.
Callispora potoniei (= Dev) Bharad. & Kumar
Lametatriletes indicus Singh & Kumar
L. mesozoicus Kumar
L. tenuis Kumar
Boseisporites insignitus Venkata.
B. jabalpurensis Kumar
Boseisporites sp.
Murospora sp.
Contignisporites cooksonii (Balme) Dettm.
Densoisporites mesozoicus (Singh *et* al.)
Laevigatosporites gracilis Bharad. & Kumar
Monolites indicus Kumar
Dettmannites attenuarus Kumar
Rouseisporites sehoraensis Singh
R. densus Kumar
Callialasporites dampieri (Balme) Bharad. & Kumar
C. segmentatus (Balme) Bharad. & Kumar
C. trilobatus (Balme) Bharad. & Kumar

C. doringii Kumar
C. indicus (Singh & Kumar) Kumar
C. enigmaticus (Singh & Kumar) Kumar
C. plicatus (Singh & Kumar) Kumar
C. primus (Singh & Kumar) Kumar
C. limbatus (Singh & Kumar) Kumar
C. discoidalis (Döring) Bharad. & Kumar
C. circumplectus Kumar
C. sehoraensis (Singh & Kumar) Kumar
C. lametaensis Kumar
C. ovatus Venkata.
C. rudisaccus Maheshwari
C. baculosus (Dev) Maheshwari
Vitreisporites pallidus (Reiss.) Nils.
Alisporites ovalis Kumar
A. mesozoicus Kumar
A. haradensis Kumar
A. sehoraensis Kumar
A. similis (Balme) Dettm.
Abiespollenites triangularis Kumar
Phyllocladidites riiei Cookson
Klausipollenites australiensis (de Jersey) Bharad. & Kumar (MS)
Podocarpidites ellipticus Cookson
P. multesimus (Bolkhov.) Pocock
P. cristiexinus Sah & Jain
P. grandis Sah & Jain
Podocarpidites vermiculatus Kumar
Baculopollenites haradensis Kumar
Striated bisaccates
Podosporites tripakshi Rao
Cycadopites couperi (Dev) Kumar
C. gracillis Sah & Jain
Araucariacites australis Cookson
A. jabalpurensis Kumar (in Thesis 1970)
A. indicus (Singh *et al.*) Kumar
A. ghuneriensis Singh *et al.*
A. limbatus Kumar
Classopollis cf. *C. classoides* (Reiss.) Coup.
C. indicus Maheshwari

Quantitatively, the mioflora is characterized by the predominant occurrence of coniferalean contents. Cryptogamic and cycadalean or benettitalean elements are poor in the assemblage. The percentage frequency of various miospores distributed in the assemblage is given in Tables 2, and 3. The composition of the mioflora is based on a count of 200 spore specimens per sample. Out of 31 miospore genera and 71 species only 25 genera and 60 species of them have figured in the counting (Histogram-1).

The miospore genera or species represented by 30 per cent or more are considered as *prominent* members of the assemblage. Components, between 20 but below 30 per cent have been treated as *Common*, whereas those which are below 20 but up to 10 per cent are

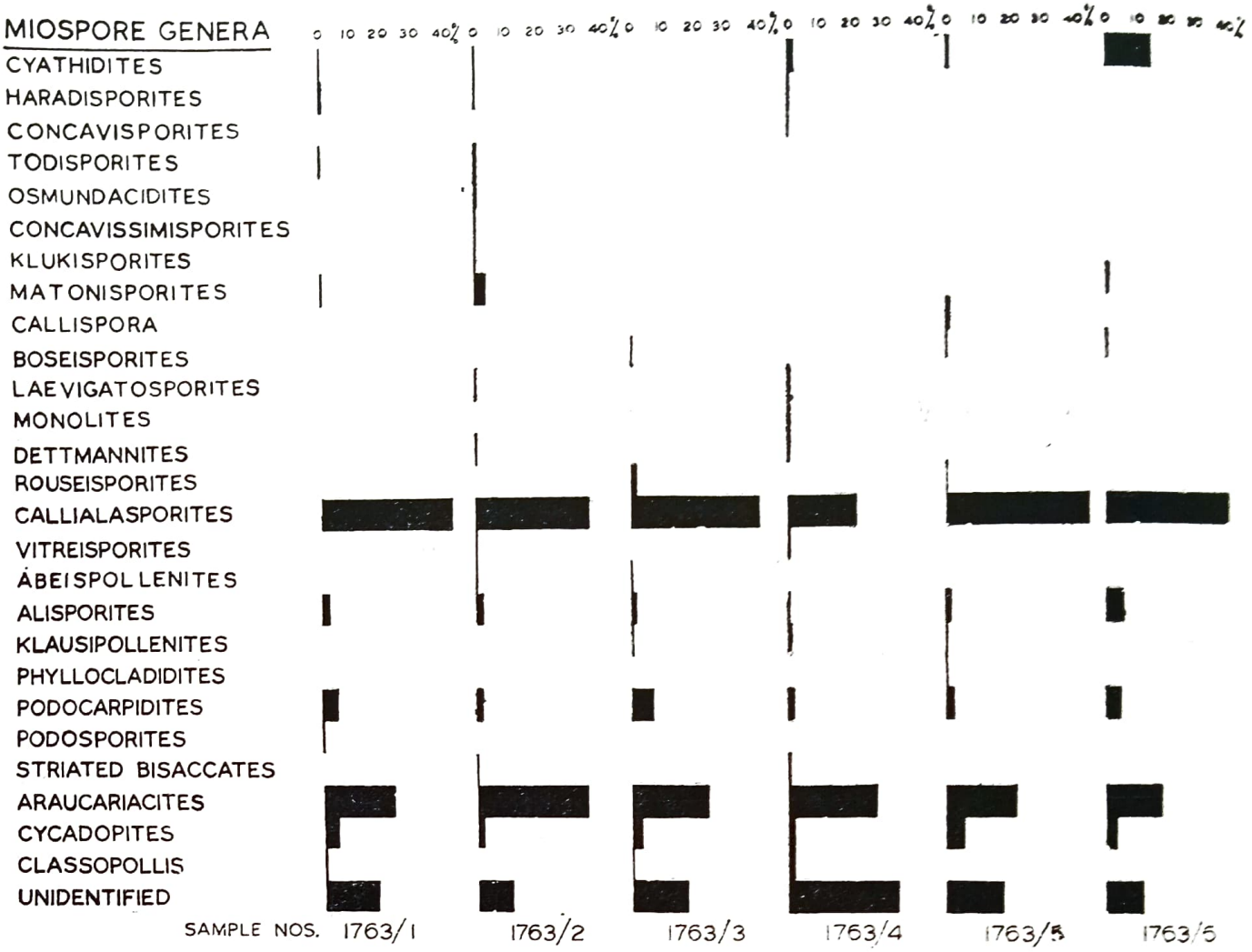
Table 2—Percentage frequency of miospore species

Miospore Species/Sample Nos.	1763/1	1763/2	1763/3	1763/4	1763/5	1763/6
Cyathidites australis	..	..	..	..	0.5	11.5
C. minor	0.5	..	..	2.0	0.5	3.5
C. densus	..	0.5	..	..	..	..
Haradisporitds mineri	1.0	..	..	0.5	..	..
H. scabratus	..	0.5	..	..	..	..
Concavisporites novicus	..	..	..	0.5	..	..
Todisporites minor	0.5	0.5	..	..	..	..
T. major	..	0.5	..	..	..	..
Osmundacidites welmanii	..	1.0	..	..	..	..
Concavissimisporites sp.	..	0.5	..	..	..	..
Klukisporites haradensis	..	0.5	..	..	..	..
Matonisporites dubius	0.5	3.5	..	..	..	1.0
Callispora potoniei	..	..	..	..	1.0	..
Boseisporites insignitus	..	..	0.5	..	..	..
B. jabalpurensis	..	..	..	..	0.5	..
B. sp.	..	..	..	..	..	0.5
Laevigatosporites gracilis	..	0.5	..	0.5	..	..
Monolites sp.	..	..	..	0.5	..	..
Dettmannites attenuarus	..	0.5	..	0.5	..	..
Rouseisporites densus	..	..	1.5	..	..	..
R. sehoraensis	..	..	0.5	..	0.5	..
Callialasporites trilobatus	4.0	6.0	5.5	2.0	5.5	3.5
C. dampieri	23.0	23.5	19.0	17.0	32.0	25.5
C. segmentatus	4.0	2.0	2.5	1.0	1.5	1.5
C. primus	0.5	..	..	..	..	..
C. enigmaticus	0.5	0.5	0.5	..	..	1.5
C. döringii	1.0	..	1.0	..	..	..
C. circumplectus	3.5	..	1.5	0.5	1.0	3.5
C. sehoraensis	3.0	..	0.5	..	..	0.5
C. indicus	2.0	4.0	1.5	..	1.5	3.0
C. plicatus	1.0	0.5	4.0	..	..	0.5
C. limbatus	..	..	..	..	2.5	0.5
C. rudisaccus	..	..	3.5	0.5	..	..
C. baculosus	..	..	1.5	..	..	..
C. lametaensis	..	..	..	1.0	1.0	..
Vitreisporites pallidus	..	0.5	..	1.0	..	..
Abiespollenites triangularis	..	..	0.5	..	..	..
A. sp.	..	0.5	..	..	..	..
Alisporites mesozoicus	2.5	1.5	..	0.5	..	3.0
A. ovalis	..	0.5	0.5	..	..	1.0
A. grandis	..	0.5	..	..	..	..
A. similis	..	..	0.5	..	0.5	..
A. sehoraensis	..	..	0.5	..	..	..
A. haradensis	..	..	..	..	1.0	1.5
Klausipollenites australiensis	..	..	0.5	1.0	0.5	..

Phyllocladidites rüei	..	..	..	..	0.5	..
Podocarpidites ellipticus	5.0	0.5	1.0	..	..	1.0
P. cristiexinus	..	1.5	3.0	0.5	1.5	3.5
P. vermiculotus	..	..	3.0	..	..	..
P. multisimus	..	..	..	1.5	1.0	..
Podosporites tripakshi	0.5	..	..	..	..	..
Striated bisaccates	..	0.5	..	1.0	..	..
Araucariacites australis	5.0	3.5	13.0	1.0	10.5	5.0
A. jabalpurensis	18.5	31.5	11.5	27.0	10.5	13.0
A. indicus	..	1.0	0.5	..	1.0	..
A. ghuneriensis	..	..	..	0.5	..	..
A. limbatus	..	..	..	..	0.5	..
Cycadopites couperi	4.5	2.0	3.5	1.5	6.0	3.5
C. gracilis	0.5	..	..	0.5	..	..
Classopollis indicus	1.0	..	..	2.0	..	..
C. cf. *classoides*	..	..	0.5	..	..	..
Unidentified	17.5	11.0	18.0	35.5	18.5	12.0

Table 3—Percentage frequency of miospore genera

Spore Genera/Sample Nos.	1763/1	1763/2	1763/3	1763/4	1763/5	1763/6
Cyathidites	0.5	0.5	..	2.0	1.0	15.0
Haradisporites	1.0	0.5	..	0.5	..	..
Concavisporites	..	..	..	0.5	..	..
Todisporites	0.5	1.0	..	..	..	..
Osmundacidites	..	1.0	..	..	..	..
Concavissimisporites	..	0.5	..	..	..	..
Klukisporites	..	0.5	..	..	..	..
Matonisporites	0.5	3.5	..	..	..	1.0
Callispora	..	..	..	..	1.0	..
Boseisporites	..	..	0.5	..	0.5	0.5
Laevigatosporites	..	0.5	..	0.5	..	..
Monolites	..	..	..	0.5	..	..
Dettmannites	..	0.5	..	0.5	..	..
Rouseisporites	..	..	2.0	..	0.5	..
Callialasporites	42.5	36.5	41.0	22.0	45.0	40.0
Vitreisporitss	..	0.5	..	1.0	..	..
Abiespollenites	..	0.5	0.5	..	..	..
Alisporites	2.5	2.5	1.5	0.5	1.5	5.5
Klausipollenites	..	..	0.5	1.0	0.5	..
Phyllocladidites	..	..	..	..	0.5	..
Podocarpidites	5.0	2.0	7.0	2.0	2.5	4.5
Podosporites	0.5	..	..	..	..	..
Striated bisaccates	..	0.5	..	1.0	..	..
Araucariacites	23.5	36.0	25.0	28.5	22.5	18.0
Cycadopites	5.0	2.0	3.5	2.0	6.0	3.5
Classopollis	1.0	..	0.5	2.0	..	..
Unidentified	17.5	11.0	18.0	35.5	18.5	12.0



Histogram 1. Showing percentage frequency of miospore genera from Kotri, Narsinghpur.

taken to be *fair*. Between 10 to 5 per cent are termed as *poor* and those occur less than 5 per cent have been considered as *rare*. The *very rare* components are those which do not come in the counts but are observed to occur in the assemblage.

A critical appraisal of the miospores recovered from the six coal and carbonaceous shale samples in succession from bottom to top has revealed that the following spore genera and species are quantitatively significant.

Callialasporites dampieri

C. trilobatus

Araucariacites jabalpurensis

A. australis

The association of various taxa and their frequency occurrence in the various samples clearly show that the miofloral represents a single assemblage unit and does not show any marked difference in the miofloral composition, except a few minor differences in their percentage frequency from bottom to top beds.

Right from bottom sample to top, the monosaccate genera *Callialasporites*, presumably podocarpaceae, and *Araucariacites* belonging to family araucareaceae, are the 'prominent' elements of the assemblage, though the latter being represented as 'common' in the top sample no. 6 (18.0%). Monocolpate pollen grains as referred to the genus *Cycadopites* belonging to Cycadales or Bennettitales, are 'fair' in sample nos. 1 and 5, in other samples it is recorded as 'poor'. The appearance of bisaccate pollen grains, viz. *Podocarpidites* and *Alisporites* does not show a constant figure. Their quantitative frequencies vary from 'fair' —'poor'—'rare' in various samples. The other miospore genera, listed in Table 2, either

appear as 'poor' or 'rare' in the assemblage excepting *Cythidites* which suddenly rises up to 'common' (15.0%) only in sample no. 6. The badly preserved miospores which are difficult to identify them have been figured under unidentified in the counts.

A count of miospore species has also been attempted here. Numerically, significant species are *Callialasporites dampieri*, *Araucariacites jabalpurensis* and *A. australis*. Species *C. dampieri* is 'prominent' in sample nos. 1, 2, 5 and 6 but it becomes 'common' in sample nos. 3 and 4. Likewise, *Araucariacites jabalpurensis* is 'common' in sample nos. 1, 3, 5 and 6 but graded up to 'prominent' in sample nos. 2 and 4. *A. australis* is found as inconsistent element in all the samples.

COMPARISON OF THE MIOFLORA

The comparable Upper Mesozoic miofloral assemblages known so far from India are meagre. Mostly the carbonaceous facies belonging to Upper Mesozoic are found in the detached outliers. The miofloras of the Jabalpur Series have been studied from Satpura and South Rewa Gondwana basins by various workers. From the Satpura basin, DEV (1961), SINGH (1966), KUMAR (1973), BHARADWAJ *et al.* (1972) studied the sporological assemblages from Sehora, Hathnapur and Lameta Ghat, MAHESHWARI (1973) and BHARADWAJ AND KUMAR (1974) from Parsapani, and MAHESHWARI AND KUMAR (1979) from Morghat Section which is the extreme western outlier of the basin. From South Rewa Gondwana basin, in the year 1974, BHARADWAJ AND KUMAR, and MAHESHWARI dealt with the palynostratigraphy of carbonaceous deposits from Bansa, Madhya Pradesh. Similar miofloa has also been recorded from the Kutch basin from Upper Katrol near Bhuj by VENKATACHALA, KAR AND RAZA (1969) and BHARADWAJ (1969).

Qualitatively, the miofloa from Kotri shows close resemblance to those described from Sehora, Hathnapur and Lameta Ghat (DEV *l.c.*, and KUMAR, *l.c.*), Morghat Section (MAHESHWARI & KUMAR 1979), Parsapani (MAHESHWARI, *l.c.*, BHARADWAJ & KUMAR, *l.c.*) and from Bansa (MAHESHWARI, *l.c.*, and BHARADWAJ & KUMAR, *l.c.*) except a few minor differences in the occurrence of some spore and pollen genera or species, otherwise the above mentioned miofloras are definitely homotaxial in their miofloral spectrum. The Bansa mioflora (MAHESHWARI. *l.c.*) differs from the studied one in having the miospores namely *Impardecispora*, *Pilosisporites*, *Lakhnavitriltetes* which are absent in the latter. Assemblage from Bhuj, Upper Ketrol is different from the Kotri in view of having the cryptogamic miospores which are absent in the latter viz *Impardecispora*, *Pilosiporites*, *Bhuijiasporites*, *Katrolaites*, etc.

Quantitative analysis of the mioflora from Kotri reveals that it possesses the close association of pollen grains viz., *Callialasporites* and *Araucariacites*. In composite frequency percentage, the genus *Callialasporites* (± 37.66%) appears as prominent in the assemblage. *Araucariacites* (±25.50%) comes next to it and *Podocarpidites* occurs ±4 per cent. Such miofloral association has also been reported from Morghat Section (MAHESHWARI & KUMAR 1979) in which *Callialasporites* and *Araucariacites* are represented by ±54.0% and ±35.0% respectively. The same association has been recorded from the lower samples of Lameta Ghat, viz., sample Nos. 97/7, 8 and 9 (BHARADWAJ *et al.*) which contain *Callialasporites* ±27%, *Araucariacites* ±12 per cent, *Cycadopites* ±16% and *Podocarpidites* ± 15%. Likewise, assemblage-A from Bansa, South Rewa Gondwana basin (BHARADWAJ & KUMAR *l.c.*) possesses *Callialasporites* ±46.5%, *Araucariacites* ±26% and *Podocarpidites* ± 16%. However, in view of the above distribution, assemblages from Lameta Ghat and Bansa seem to be different from that of Kotri in being higher percentages of *Cycadopites* and *Podocarpidites*. From Kutch, *Botton palynozone* of Upper Katrol near Bhuj (BHARADWAJ *l.c.*)

compares very well with the Kotri assemblage. The former has the prominence of *Callialasporites* (±50%), which is followed by *Araucariacites* (±25%) and *Podocarpidites* is represented by (±5%). Hence, the Bottom zone of Upper Katrol closely resembles quantitatively the latter one. The mioflora from Parsapani shows the prominence of *Podocarpidites* (36 per cent) associated with *Callialasporites* (17 per cent) and *Araucariacites* (16 per cent) as stated by BHARADWAJ AND KUMAR (*l.c.*) but the picture of quantitative analysis of Parsapani as given by MAHESHWARI (*l.c.*) differs in having prominence of *Araucariacites* and followed by *Callialasporites*. In this respect both the described analyses of Parsapani have no comparison with that of Kotri.

CONCLUSION

CROOKSHANK (1936) opined that the carbonaceous facies deposited near Chhindkhera village belongs to Jabalpur Series. The red Denwa clays interbedded with the Jabalpur carbonaceous shales as mentioned by him has not been seen by us in this section. These carbonaceous rocks palynologically indicate its close relationship with the other known miofloras of Jabalpur Series as already stated above. In view of the above miofloral comparison, it reveals that the Kotri miofloral assemblage correlates very well mostly with the lower parts of the various known sections such as in Lameta Ghat, Assemblage-A from Bansa, Bottom palynozone of Upper Katrol and Microflora IIa of Western Australia (BALME, 1957) which was dated as Oxfordian to Kimmeridgian in age. The microflora IIa also shows the higher incidence of *Callialasporites dampieri* which is also represented as 'prominent' here. The chief distinguishing feature of the Australian assemblage is the occurrence of *Gleicheniidites* cf. *circinidites* and *Podocarpidites ellipticus* in abundance whereas they are meagre in occurrence in the present one. Such minor variation in the percentage frequency might be due to preservation factors or the meagre occurrence of gleichenaceous stock in the Jabalpur Series. It also suggests us that such flora might not be flourishing well in the nearby regional forests of Satpura Gondwana basin.

Hence, in view of the above facts, palynologically the carbonaceous sediments at Kotri certainly belong to the older unit in the Jabalpur Series which is variably dated as Middle Jurassic to Lower Cretaceous by many of the workers on the basis of their findings.

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