

# Palynostratigraphy of the Bijori sediments, Satpura Basin, India

O.S. Sarate<sup>\*</sup> & G.V. Patil<sup>\*\*</sup>

<sup>\*</sup>*Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007*

<sup>\*\*</sup>*Amravati University, Amravati 444602, Maharashtra*

Sarate, O.S. & Patil, G.V. 1994. Palynostratigraphy of the Bijori sediments, Satpura Basin, India. *Geophytology* 23(2):197-201.

The palynoflora recovered from the Bijori sediments exposed near Bijori village in Satpura Basin is dominated by *Striatopodocarpites*, *Faunipollenites* and *Crescentipollenites*. The presence of *Crescentipollenites* and *Lunatisporites* shows its affiliation well with the palynoflora known from the uppermost Permian sediments of Damodar Valley, Son-Mahanadi and Godavari basins. However, some palynomorphs showing younger affinity were also recorded.

**Key-words**—Palynostratigraphy, Bijori Formation, Satpura Basin, Gondwana, India.

## INTRODUCTION

THE Bijori Formation exposed in the type area have been considered homotaxial in age with Raniganj Formation in Damodar Basin. Cotter (1917) assigned Upper Permian age to Bijori sediments on the basis of floral and faunal records known from Satpura Gondwana Basin. Oldham (1893) pointed out a close similarity between the plant fossils recovered from both Raniganj and Bijori sediments. Feistmantel (1879) for the first time studied the megafossils of Bijori sediments in detail. Later, Fox (1934) and Crookshank (1936) also studied megafossils from the Bijori sediments and assigned an Upper Permian age. On the basis of palynological analysis, Bharadwaj *et al.* (1978) and Saluja and Kindra (1984) supported the Upper Permian age of these sediments. Bhardwaj *et al.* (1979) however, separated the Khakhi green shales at the top of Bijori Formation and proposed a separate lithounit, Sukhtawa Formation, and considered it equivalent to the Panchet sediments of Damodar Basin.

The general geological succession of Satpura Basin is detailed below (after Raja Rao, 1983).

Age	Formation	Lithology (Thickness)
-----Unconformity-----		
Upper part of lower to middle Triassic	Denwa	Soft variegated clay interbedded with sandstone bands, conglomeratic at places

Age	Formation	Lithology (Thickness)
Upper Permian	Pachmarhi	White, coarse grained cross bedded sandstones with lenses of sub-angular quartz pebbles (about 750 m)
	Bijori	Micaceous, flaggy sandstones and shales (180-250 m)
Lower Permian	Motur	Buff green and variegated clays with coarse to very coarse grained sandstones (about 750 m)
	Barakar	Coarse to medium grained sandstones, carbonaceous shales and coal seams (250 - 450 m)
Upper Carboniferous	Talchir	Dimictites, grey sandstones and olive-green needle shales, varves and rhythmites (about 490 m)
-----Unconformity-----		
Precambrian		Gneiss, schists, quartzites, limestones, etc.

## GENERAL GEOLOGY

The Bijori Formation is succeeded by thick beds of coarse, white massive sandstone separated with each other by white quartz pebbles, frequently represented by angular clips of felspar and rare occurrence of clays in Mahadewa range representing the type area for Pachmarhi Formation. The contact between Bijori and Mahadewa formations is most debatable in Gondwana stratigraphy of Satpura Basin.

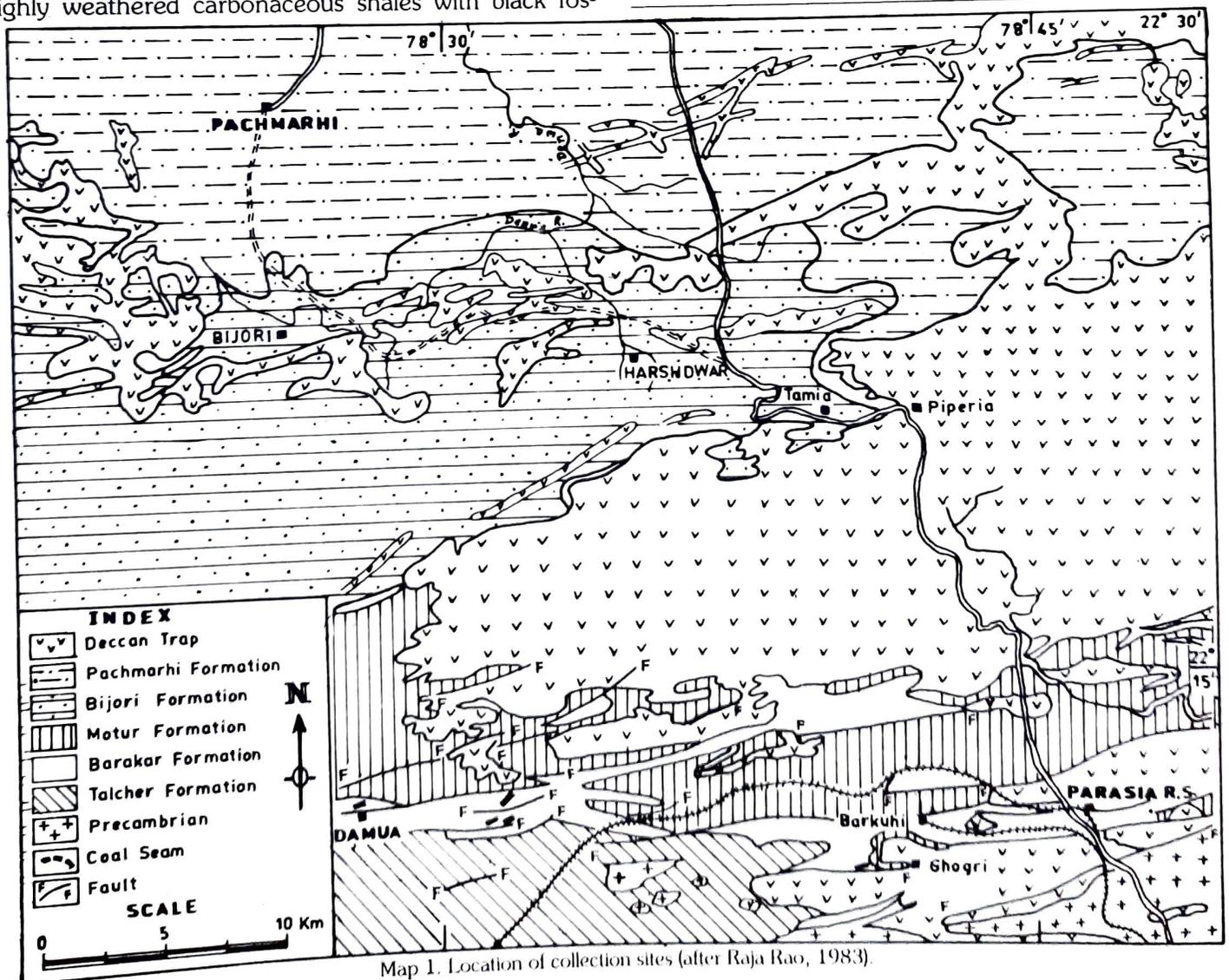
The Bijori sediments in Satpura Gondwana Basin represents a very significant lithological unit. It is characterised by variable lithologies from bottom to top portions of Bijori sediments. The lower part is dominantly composed of sandstones and shales. They are succeeded by a very characteristic lithology of Khakhi green shales, carbonaceous shales, red shales, interbedded with sandstones. The topmost portion of Bijori unit is marked by a conglomerate characterised by the presence of rounded to sub-rounded pebbles of quartzites cemented in a sandy matrix. At some places the Bijori sediments are overlain by the much younger Bagra conglomerates in Tawa river section. The contact between the Bijori and the Bagra units is unconformable in nature. Sometimes it is very difficult to mark this contact because the only distinction between these conglomerate units lies in the presence of red jasper pebbles. In fact this marks the distinction between these two lithounits. Tawa river section, about 400-500 m down stream from the Tawa Dam near Ranipura, is an ideal site for these lithounits.

*Denwa river section* — About 3 m thick sequence of highly weathered carbonaceous shales with black fos-

siliferous shale at the bottom is exposed on the left bank of Denwa river, about 1 km north of Bijori village. Plant megafossils are present in plenty in these shales. The samples for present investigation were collected from this area. The upper contact of Bijori shales is with massive Pachmarhi sandstone (Map 1).

**Table 1. List of samples collected from Denwa river section, Satpura Basin**

Sr. no.	Sample no.	Lithology	Palyno-spores Present (+) Absent (-) Badly preserved (*)
1	BF	Carbonaceous shale	+
2	BH-2	-do-	*
3	BH-3	-do-	*
4	BH-4	-do-	*
5	BH-5	-do-	-
6	BH-6	-do-	-
7	BH-7	-do-	-
8	BH-8	-do-	-



Map 1. Location of collection sites (after Raja Rao, 1983).

*Harshdwar nala section* — The area lies at about 6-8 km east of Bijori village and can be approached by Piparia-Tamia road. The locality lies at a distance of about 2 km west of Makardhdhana village. Khakhi green shales and highly weathered micaceous shale with weathered carbonaceous shale at the bottom are seen exposed in a small nala called Harshdwar nala. The sediments trend E-W and generally dip towards north from 10°-15°. A prominent dyke is also present in nearby vicinity.

**Table 2. List of samples collected from Harshdwar nala section, Sapura Basin**

Sr. no.	Sample no.	Lithology	Palyno-spores Present (+) Absent (-)
1	H-1	Khakhi micaceous sandstone	-
2	H-2	Grey shale	-
3	H-3	Khakhi sandstone	-
4	H-4	Khakhi shale	-
5	H-5	Hard Khakhi shale	-
6	H-6	Khakhi (greenish) shale	-
7	H-7B	Khakhi micaceous sandstone	-
8	H-7A	Hard carbonaceous shale	+
9	H-8	Khakhi shale	+
10	H-8A	Carbonaceous shale	-
11	H-8B	Carbonaceous shale	-
12	H-8C	Hard Khakhi shale	-
13	H-9A	Hard greenish shale	-
14	H-9B	Hard Khakhi shale	-
15	H-10	Hard Khakhi shale	-

The study of palynostratigraphy of Bijori sediments from the type area and the sediments exposed on the southern flank of Pachmarhi plateau has been undertaken since, nothing is known about their palynological contents so far.

### PALYNOFLORA

The palynofloral investigations from Harshdwar nala sections (Table 3) revealed that these sediments are dominated by *Striatopodocarpites* (44.5-28%) while, *Faunipollenites* (20-30%) subdominates the assemblage. *Crescentipollenites* (11-4.5%), *Lunatisporites* (7.5-4.5%) are next in order of dominance. *Scheuringipollenites* (4-17.5%) has shown a sudden rise in its percentage distribution in sample No. H-8. *Cyclobaculisporites* is recorded to be (5-4.5%). The palynofloral assemblage also contains *Horriditriteles*, *Ginkgocycadophytus*, *Klausipollenites*, *Microbaculispora*, *Navalesporites*,

*Rhizomaspora* and *Striatites* with a low frequency range of 1-3% (Histogram 1).

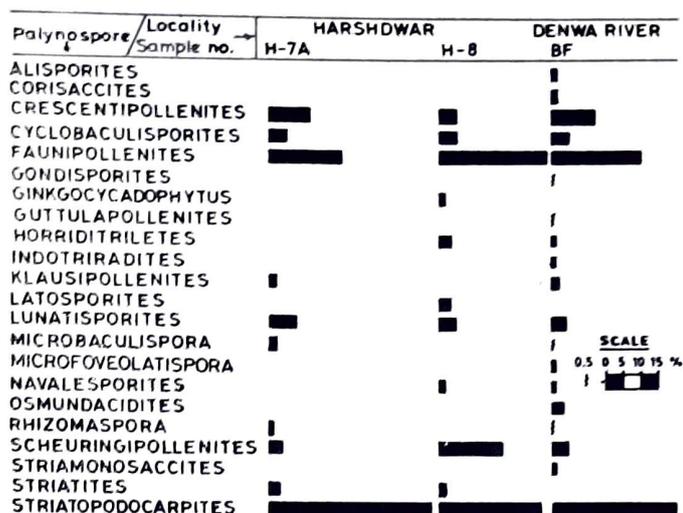
The samples from Denwa river section (Table 3) contain *Striatopodocarpites* (35%), *Faunipollenites* (24.5%) and *Crescentipollenites* (12%). However, *Scheuringipollenites* (4.5%) showed a decreasing tendency. *Cyclobaculisporites* and *Lunatisporites* are recorded up to (4.5%). In addition to these *Striamonosaccites*, *Osmundacidites*, *Navalesporites*, *Microbaculispora*, *Latosporites*, *Klausipollenites*, *Indotriradites*, *Horriditriteles*, *Guttulapollenites*, *Gondisporites*, *Corisaccites* and *Alisporites* have also been recorded and their frequency is restricted to 1-3% (Histogram 1).

**Table 3. Percentage distribution of the palynotaxa representing Harshdwar Nala Section and Denwa River Section, Sapura Basin**

Genera recorded	Harshdwar Nala Section S.no.H-7A	Denwa River S.no.H-8. BF
<i>Alisporites</i>	-	1
<i>Corisaccites</i>	-	1
<i>Crescentipollenites</i>	11	12
<i>Cyclobaculisporites</i>	5	4.5
<i>Faunipollenites</i>	20	24.5
<i>Gondisporites</i>	-	0.5
<i>Ginkgocycadophytus</i>	-	1.5
<i>Guttulapollenites</i>	-	0.5
<i>Horriditriteles</i>	-	3
<i>Indotriradites</i>	-	1
<i>Klausipollenites</i>	2	.2
<i>Latosporites</i>	-	3
<i>Lunatisporites</i>	7.5	4.5
<i>Microbaculispora</i>	2	0.5
<i>Microfoveolatispora</i>	-	1
<i>Navalesporites</i>	-	1.5
<i>Rhizomaspora</i>	1	0.5
<i>Osmundacidites</i>	-	3
<i>Scheuringipollenites</i>	4	17.5
<i>Striamonosaccites</i>	-	1
<i>Striatites</i>	3	1.5
<i>Striatopodocarpites</i>	44.5	28.5

### DISCUSSION AND CONCLUSION

Medlicott (1873) described about 600 m thick strata exposed around Bijori village, south of Pachmarhi plateau as Bijori Formation. The evidence of current bedding, ripple marks and occurrence of plant megafossils indicate a shallow depositional environment. Feistmantel (1879) and Crookshank (1936) described the following plant



**Histogram 1.** Percentage distribution of palynoflora recovered from Harshdwar nala section and Denwa river section.

fossils from Bijori sediments: *Schizoneura gondwanensis* Fst., *Trizygia speciosa* Royle, *Diksonia* sp., *Cladophlebis* (*Alethopteris*) *phegopteroides*,\* *C. lindleyana*\*, *Cordaites* (*Noeggerathiopsis*) *hislopi*, *Glossopteris communis* Fst., *G. damudica* Fst., *G. retifera* Fst., *G. angustifolia* Bgt., *G. conspicua* Fst., *G. indica* Schimp.,\* *Gangamopteris cyclopteroides*, cf. *G. whittiana* Fst., *Glossopteris* sp., *Samaropsis* cf. *S. parvula* Heer and \*fossil tree trunks. Asterik (\*) mark indicates the additional record of fossils to the Feistmantel's list except for *Trizygia* which is not recorded by Crookshank. Lydekker (1885) described *Gondwanosaurus bijoriensis* the animal skeleton Labyrinthodont allied to *Archegosaurus* from Almod village about 1.5 km south of Bijori village. Cotter (1917) compared the plant and animal fossils with other areas and suggested an upper Permian age to Bijori Formation. Further he put forth revised classification of Lower Gondwana sequence of Satpura Basin but he did not consider plant fossil evidences and also the geology of the tract.

The knowledge regarding palynofloral contents of Bijori sediments is very limited. Bharadwaj *et al.* (1978) carried out palynological study of Bijori sediments from Sukhtawa area which represents the north-western part of Panch-Kanhan-Tawa valley. The palynoflora is comparable with present assemblage in view of the dominance of *Striatopodocarpites* and *Faunipollenites*. However, they differ in having *Corisaccites* + *Guttulapollenites* complex and *Densipollenites*. *Crescentipollenites* occurs up to (2%) in Sukhtawa area, while in the present study it has been recorded up to (12%). Similar palynoflora has also been described by Salujha and Kindra (1984) from Bijori sediments. The palynoflora is closely comparable to the Late Permian palynoassemblage zone

III described by Srivastava and Jha (1990) from Mailaram area of Godavari Graben. It is also comparable to the Upper Permian palynofloral assemblage 'A' recorded from Saburband village east of Raniganj Coalfield and Nonia nala section, north of Damodar river (Bharadwaj *et al.* 1979). The palynoflora is also comparable to the palynoflora recorded by Tiwari and Ram-Awatar (1990) from Sehra nala section, Mahkor village of Son Graben. Tiwari and Singh (1986) considered *Striatopodocarpites-Crescentipollenites* assemblage zone at the top of Raniganj Formation, assigning an Upper Permian age.

In Damodar and Son-Mahanadi basins, the striate disaccates + *Densipollenites* assemblage is succeeded by Striate disaccates + *Crescentipollenites* rich assemblage. In Mailaram area of Godavari Graben *Guttulapollenites* + *Corisaccites* assemblage and *Densipollenites* assemblage is succeeded by *Crescentipollenites* rich assemblage representing the youngest assemblage in Upper Permian sediments.

Thus, the present palynofloral assemblage from Harshdwar nala and Denwa river section is younger than the palynoflora described from Sukhtawa area by Bharadwaj *et al.* (1978) and represents the top of the Upper Permian palynofloral succession in Satpura Basin. The presence of *Gondisporites*, *Navalesporites* and *Osmundacidites* though in rare percentages, also show its Upper Permian affinity. However, the appearance of *Klausipollenites* in this assemblage indicates close proximity towards the Permian-Triassic transition. The present investigation further suggests that the khakhi green shales (Sukhtawa Formation) overlying the carbonaceous shales may be considered equivalent to the Panchet Formation of the Damodar Valley, though the palynological support is still desired.

## ACKNOWLEDGEMENTS

We express our sincere thanks to Dr Anand Prakash, Head, Department of Biodiagenesis and Dr Suresh Chandra Srivastava, Head, Department of Pre-Gondwana and Gondwana Palynostratigraphy of Peninsular India for extending help in the collection of samples and their valuable suggestions.

## REFERENCES

- Bharadwaj, D.C. Tiwari, R.S. & Anand-Prakash 1978. Palynology of Bijori Formation (Upper Permian) in Satpura Gondwana Basin, India. *Palaeobotanist* **25**: 70-78.
- Bharadwaj, D.C., Tiwari, R.S. & Anand-Prakash 1979. Permo-Triassic palynostratigraphy and lithostatigraphical characteristics in Damodar Basin, India. *Biol. Mem.* **4** (1 & 2): 49-82.
- Cotter, G. de P. 1917. A revised classification of the Gondwana system. *Rec. geol. Surv. India* **84**: 29.

- Crookshank, H. 1936. The geology of northern slopes of Satpuras between Morand and Sher rivers. *Mem. geol. Surv. India* **66** (2): 219.
- Feistmentel, O. 1897. Palaentological Notes from Satpura coal basin. *Rec. geol. Surv. India* **52**: 74-83.
- Lydekker, R. 1885. The reptilia and Amphibia of maleri and Denwa groups. Notes on the Satpura Coal Basin. *Pal. Indica Ser. 4*, Vol. 1. pt 5: 1-16.
- Medlicott, H.B. 1873. Notes on the Satpura Coal Basin. *Mem. geol. Surv. 1 India* **10**: 159.
- Salujha, S.K. & Kindra, G.S. 1984. Gondwana palynoflora from Satpura Basin, Madhya Pradesh. *Bull. Oil Nat. Gas Commission, Dehradun* **21** (1): 47-62.
- Tiwari, R.S. & Ram-Awatar 1990. Palyno-dating of Nidpur beds, Son Graben, Madhya Pradesh. *Palaeobotanist* **38**: 105-121.
- Tiwari, R.S. & Singh, V. 1986. Palynological evidences for Permo-Triassic Boundary in Raniganj Coalfield, Damodar Basin. *Bull. geol. Min. Metal. Soc. India* **45**: 256-264.
- Raja Rao, C.S. 1983. Coal resources of Madhya Pradesh, Jammu & Kashmir, Coalfields of Satpura Gondwana Basin. *Bull. geol. Surv. India, Ser., A* (45), Coal fields of India **3** : 155-159.
- Srivastava, Suresh, C. & Jha, N. 1990. Permian-Triassic palynofloral transition in Godavari Graben, Andhra Pradesh. *Palaeobotanist*. **38**: 92-97.