PALYNOSTRATIGRAPHY OF THE TALCHIR FORMATION FROM MANENDRAGARH, MADHYA PRADESH, INDIA

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ABSTRACT

The Talchir sediments exposed in Hasdo river and Hasia nala near Manendragarh, Madhya Pradesh, India have been studied palynologically. 13 miospore genera chiefly represented by the radial monosaccates comprise the miofloral assemblages. Two characteristic palynozones have been demarcated in the measured section from Hasia nala on the basis of their qualitative as well as quantitative representation. The Palynozone 1 is characterised by the dominance of the genus *Plicatipollenites* followed by the subdominance of *Parasaccites*, *Virkkipollenites* and *Potonieisporites*. In Palynozone 2 *Parasaccites* rises to dominance while *Plicatipollenites* decreases to subdominance. The changes in mioflora have also been corroborated by the nature of sedimentation of the Talchir Formation. The Hasdo river palynoflora which has been recovered from the sediments lying immediately above the marine bed, constitutes Palynozone 3 and is younger than Palynozone 2 of Hasia nala.

INTRODUCTION

Palynological studies have been successfully utilized in recent years for the biostratigraphic zonation of the Gondwana sediments of India. Bharadwaj (1966) first synthessized the palynological succession of the Lower Gondwana sediments of India. Subsequently, Bharadwaj (1969, 1970, 1971, 1971a, 1972, 1972a), Venkatachala (1972), Sah, Singh and Sastry (1972) and Srivastava (1974) have further contributed to the distribution of miofloras in the Indian Gondwana sediments.

Talchir Formation represents the lowermost part of the Gondwana sequence of India. The palynology of these sediments has been studied as early as 1939 and 1946 by Virkki from Salt Range, West Pakistan, Daltonganj, Bihar and Pali, Madhya Pradesh, India. Potonié and Lele (1961) described the sporae dispersae of Talchir beds of South Rewa Gondwana Basin. Later on Lele and his associates further contributed towards the knowledge of sporae dispersae of Talchir sediments from Jayanti Coalfield, Manendragarh and Umaria areas. The palynoflora of Talchir sediments and the overlying coal beds was described by Bharadwaj and Anand-Prakash (1972) from Mohapni Coalfield. Later Bharadwaj and Srivastava (1973) described the palynological succession of the lower part of the Lower Gondwana sequence in a deep bore-hole from Korba Coalfield, Madhya Pradesh.

The Talchir sediments of Manendragarh were palynologically studied by Lele and Chandra (1972). However, a detailed investigation of Talchir sediments of Manendragarh has been undertaken in order to correlate the Talchir sediments in the area.

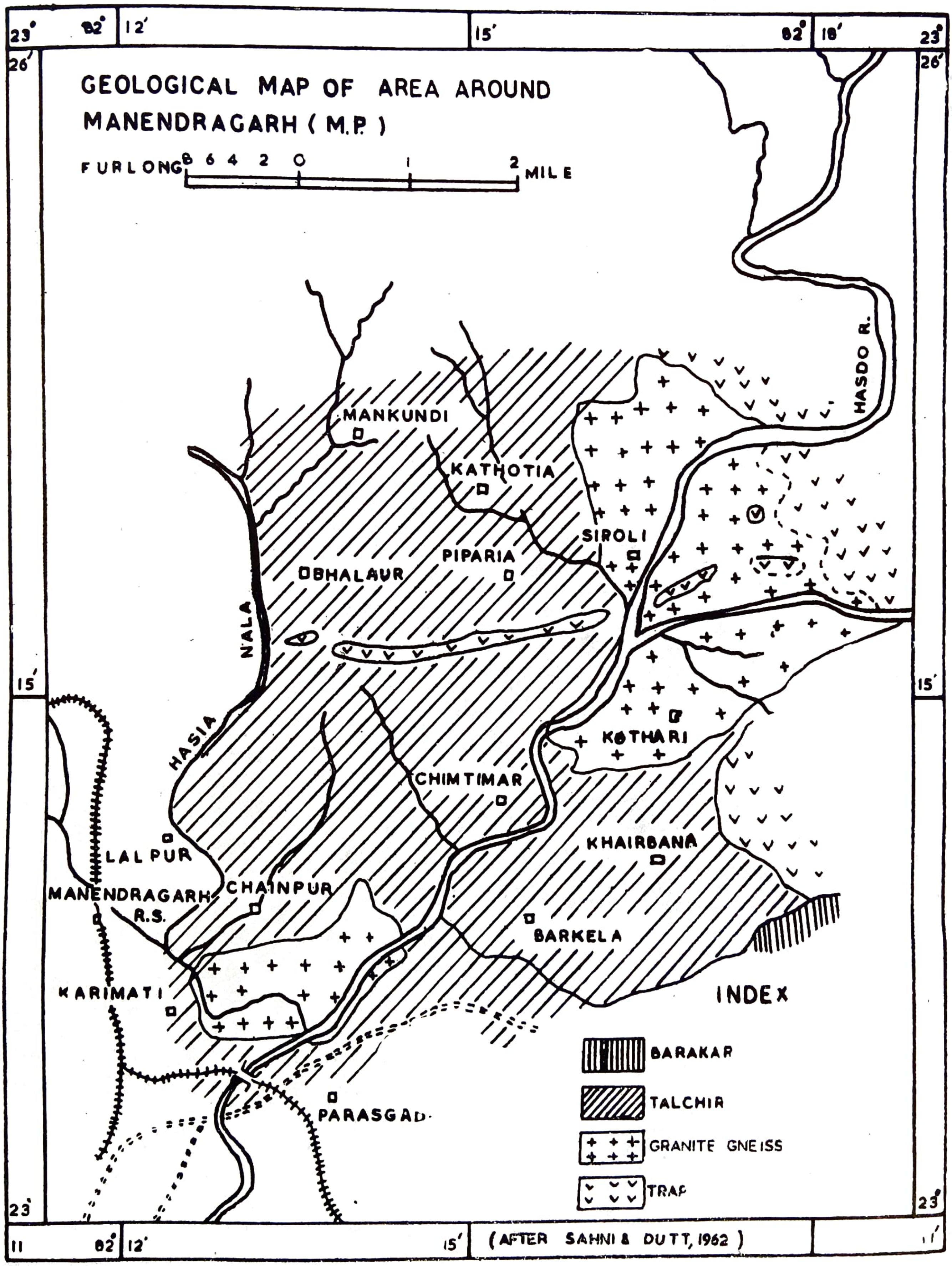
GEOLOGY

The geology of Manendragarh (N 23°13′ : E 82°33′) area has been described by Gee (1928). Recently, Ahmad and Hashimi (1974) have studied the striated pavements near Manendragarh. The Talchir sediments are well developed over a vast area and almost entire succession is exposed in Hasdo river and Hasia nala sections. The generalised stratigraphical succession is believed to be as follows :

TALCHIR	Sandstone Needle Shale Boulder Bed (with marine fossils)

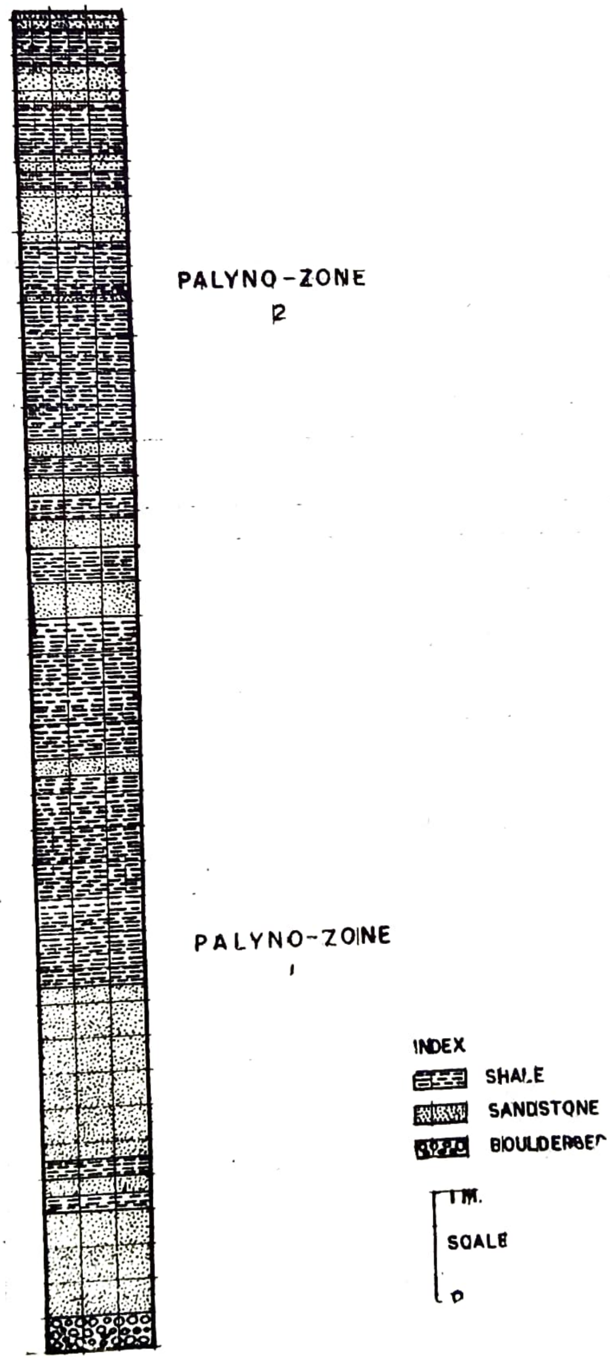
..............................Unconformity..............................

Metamorphics



Hasia Nala Section

A traverse along Hasia nala was undertaken from the village Lalpur upto its confluence with the Hasdo river (Map 1). The sediments are locally folded forming an anticline with the limbs dipping on low angles (10°—12°) towards NNW and SSE near Lalpur. However, the beds are not much disturbed and the succession of various members is represented nicely. The basement rocks are not exposed in this section. The lowermost member is a boulder bed which consists of pebbles, mostly unsorted and commonly subrounded ones. The overlying sediments include alternating bands of sandstones and shales. The sediments seen on the northern limb of the fold have been studied from measured section (Text-fig. 1). Fourteen representative samples were collected, the details of which are given in Table 1.



Text-fig. 1 : Measured lithological succession of Talchir sediments exposed in Hasia nala section, Manendragarh, M.P.

Table 1—Samples collected from Hasia Nala section between the Lalpur village and its confluence with Hasdo river (Text-fig. 1)

Sample No.	Lithology	Presence of miospores
H/1	Green sandstone	Absent
H/2	Green sandstone	Present
H/3	Green sandstone	Present
H/4	Green mudstone	Present
H/5	Green mudstone	Absent
H/6	Green mudstone	Present
H/7	Needle shale	Absent
H/8	Needle shale	Present
H/9	Needle shale	Present
H/10	Needle shale	Present
H/11	Boulder bed	Absent
H/12	Needle shale	Present
H/13	Needle shale	Absent
H/14	Boulder bed	Absent

Table 2—Samples collected from Hasdo river section from Siroli village upto water pumping station near the railway bridge

Exposure No.	Sample Nos.	Lithology	Presence of miospores
	MH/3	Needle shale (Khaki green)	Absent
1	MH/2	Greenish sandstone	Absent
	MH/1	Boulder bed at the contact with metamorphics	Absent
		Sandstone	
	MH/7	Needle shale (Khaki green)	Absent
	MH/6B	Coarse sandstone with pebbles and specs of Needle shale	Absent
	MH/6A	Pebbly bed	Absent
2	MH/5B	Dark Grey shale (Upper Part)	Absent
		Sandstone	
	MH/5A	Dark Grey shale (Lower Part)	Present
		Sandstone	
	MH/4	Boulder bed with imperfect impressions of animal fossils	Absent
		Sandstone	
	MH/9	Needle Shale (Yellowish green)	Present
3		Sandstone	
	MH/8	Boulder bed with marine animal fossils at the confluence of Hasdo river with Hasia Nala	Absent

Hasdo river section

The Talchir sediments exposed in Hasdo river between Siroli village and water pumping station near the railway bridge (Map 1) were studied. The sediments are exposed in patches mainly due to the undulated surface of the basement rocks. Boulder bed, the lowermost member of the Talchir Formation is characterised by the unsorted subrounded boulders of different size and shape which are cemented together in clayey and sandy matrix. At places marine animal fossils are also preserved in them. The best fossils are present at the confluence of Hasdo river with Hasia nala. Overlying the boulder bed are shales and sandstones (Table 2). Some of the shales are grey in colour, a feature usually not seen in Talchir sediments.

PALYNOLOGY

The mioflora of the Talchir sediments studied includes trilete, zonate, monosaccate, disaccate (striated and non-striated) and colpate pollen grains. In all 13 miospore genera have been identified on the lines suggested by Bharadwaj (1962), Bharadwaj and Salujha (1964), Bharadwaj and Tiwari (1964), Bharadwaj and Srivastava (1969), Lele (1964) and Lele and Karim (1971) which are given below :

Callumispora sp.
Plicatisporis distinctus Lele & Makada, 1972
Jayantisporites conatus Lele & Makada, 1972
Virkkipollenites densus Lele, 1964
Plicatipollenites indicus Lele, 1964
P. trigonalis Lele, 1964
P. stigmatus Lele & Karim, 1971
P. maculatus Lele, & Karim, 1971
P. densus Srivastava, 1970
Rugasaccites ovatus Lele & Makada, 1972
Parasaccites obscurus Tiwari, 1965
P. diffusus Tiwari, 1965
P. plicatus Lele & Makada, 1972
P. bilateralis Tiwari, 1965
Caheniasaccites distinctus Lele & Makada, 1972
Divarisaccus lelei Venkatachala & Kar, 1966
? *Potonieisporites coincinus* Tiwari, 1965
P. magnus Lele & Karim, 1971
P. jayantiensis Lele & Karim, 1971
Limitisporites diversus Lele & Karim, 1971
Illinites notus Lele & Karim, 1971
Striatites sp.
Faunipollenites goraiensis (Pot. & Lele) Maithy, 1965
Ginkgocycadophytus novus Srivastava, 1970

In addition to these some alete miospores have also been observed, viz. :
Pilasporites calculus Balme & Hennelly, 1956
Hemisphaerium signum Hemer & Nygreen, 1967
H. singrauliensis Sinha, 1969
Schizosporis scissus (Balme & Henn.) Hart, 1965
Balmeella gigantea Bose & Maheshwari, 1968
Leiosphaeridia bokaroensis Lele, 1975

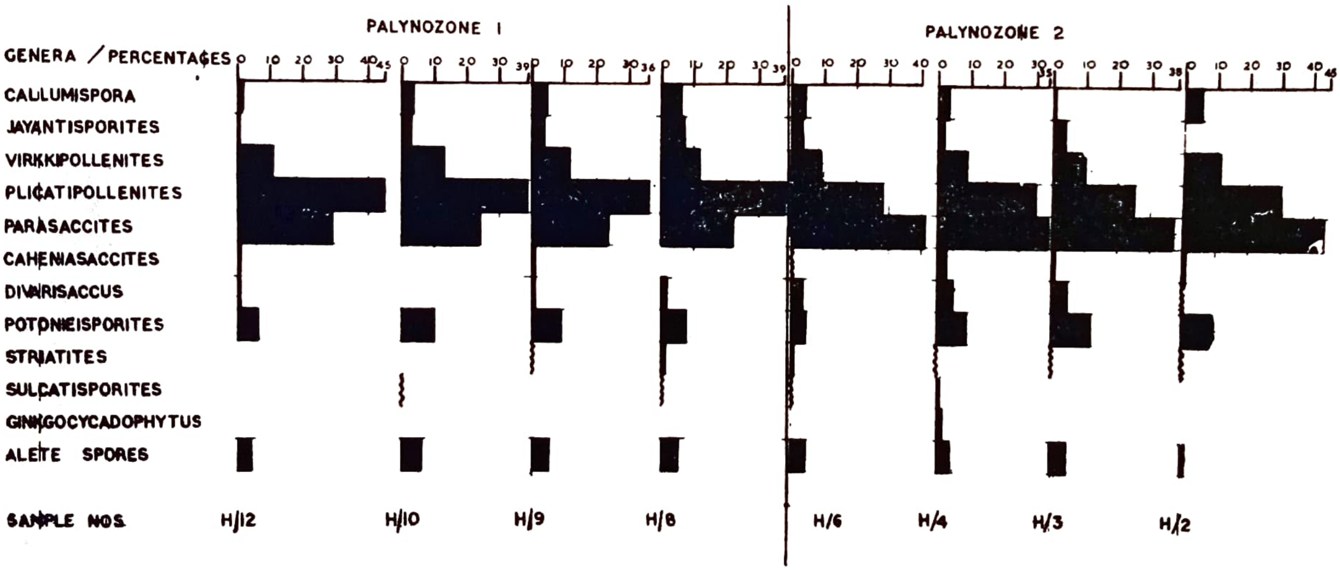
L. indica Lele & Chandra, 1972
L. talchirensis Lele & Karim, 1971
Foveofussa cylindrica Lele & Chandra, 1972
Spinose acritarch.

Hasia Nala section

The Talchir sediments exposed along Hasia Nala have yielded a considerably rich assemblage of miospores. The mioflora is essentially rich in radial monosaccate pollen grains (average 88%). However, on the basis of quantitative abundance, two distinct palynozones have been demarcated.

Palynozone 1 is characterised by the abundance of *Plicatipollenites* (36—45%, Histogram 1). The next subdominant genera are *Parasaccites* (22—30%), *Virkkipollenites* (11—13%) and *Potonieisporites* (6—10%). Triletes, disaccate and colpate pollen grains are rare in representation. This assemblage has been recorded mostly from the Khaki green needle shales present in the older part of the succession.

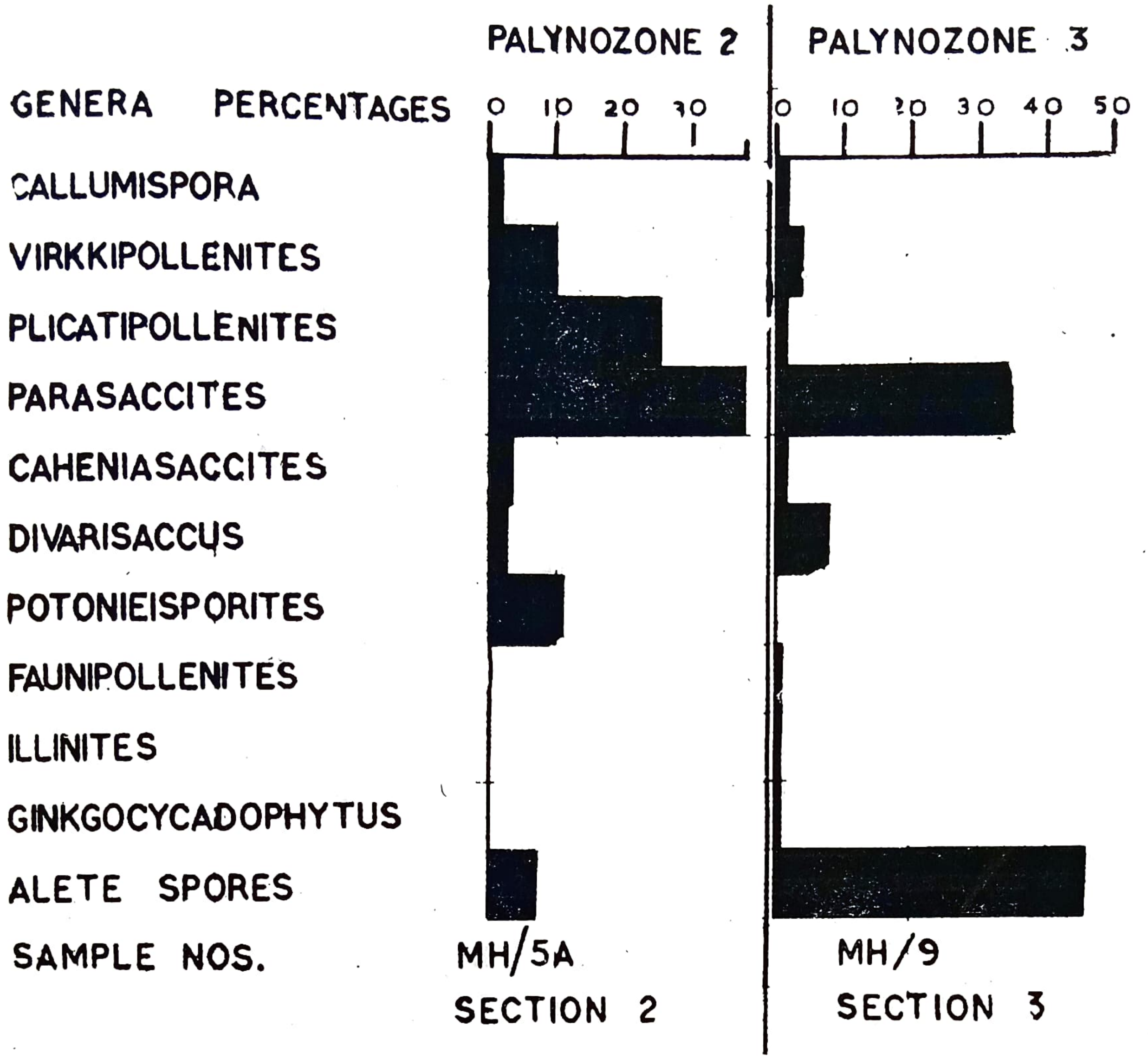
Palynozone 2 is marked by the quantitative dominance of *Parasaccites* (34—43%). *Plicatipollenites* which was dominant in Palynozone 1, has decreased to subdominance (25—30%). *Virkkipollenites* and *Potonieisporites* are represented in almost similar percentages as in Palynozone 1. *Divarisaccus* (1—5%) is consistently present as compared to the older assemblage. *Jayantisporites* shows a decreasing trend. Disaccate pollen grains are still inconsistent and rare in representation. Such an assemblage has been recorded mostly from the mudstones and sandstones associated in the younger part of the Talchir sediments.



Histogram 1—Showing quantitative representation of various miospore genera in sediments exposed along Hasia Nala, Manendragarh.

Hasdo river section

Only two samples (MH/5A, MH/9) from Hasdo river section which are lithologically different from each other have yielded miofloras essentially rich in monosaccate pollen grains (Histogram 2). The assemblage recorded from sample no. MH/5A (exposure no. 2), which is a dark grey shale, shows the dominance of the genus *Parasaccites* (38%). *Plicatipollenites* (26%), *Potonieisporites* (11%) and *Virkkipollenites* (10%) follow the dominant genus in successive order. Thus, the total representation of monosaccate pollen grains amounts to 91 per cent. Rest of the percentage is shared by *Callumispora* (2%) and alete spores (7%). This assemblage is closely comparable to Palynozone 2 of Hasia Nala section.



Histogrom 2—Showing quantitative representation of various miospore genera in sediments exposed along Hasdo River, Manendragarh.

Palynozone 3—The miofloral assemblage present in sample no. MH/9 (exposure no. 3) is also dominated by *Parasaccites* (35%) but the subdominant genera are considerably reduced as compared to those associated with it in sample no. MH/5A. On the other hand, *Divarisaccus* has increased to 8 per cent. Disaccate and colpate pollen grains together share only 6 per cent. Alete spores, spinose and non-spinose both, are present in abundance (45%) as compared to the earlier sample. This assemblage differs from the Palynozone 2 of Hasia nala section in view of the dominance of *Parasaccites*, striking reduction of *Plicatipollenites* and high incidence of alete spores. This assemblage constitutes Palynozone 3. The recalculated percentages of spore genera excluding the alete spore are *Parasaccites* 40 per cent, *Plicatipollenites* 7 per cent, *Virkkipollenites* 9 per cent, *Divarisaccus* 13 per cent. The high incidence of alete spores suggests a near shore deposition of the needle shale containing it.

DISCUSSION

The discovery of marine fossils by Ghosh (1954) from a bed under the railway bridge on Hasdo river initiated active research in the Talchir sediments of Manendragarh area. Later on Datta (1957) reported another occurrence of marine fossils $2\frac{1}{2}$ kilometers north of Manendragarh on the right bank of Hasdo river. On the find of *Eurydesma* and *Aviculopecten* a marine transgression, deep into this part of peninsular India was visualised.

SAHNI AND DUTT (1962) described the marine fauna from Manendragarh and Siroli, compared their assemblage with the marine faunas of Argentina and Australia and considered it to be Permo-Carboniferous in age. Since no *Productus* was reported in Manendragarh fauna, it was considered older than the one at Umaria. This is also presumed from the fact that the marine bed at Manendragarh is supposed to be at the base of the Talchir Formation while at Umaria it is presumed to be at the top of the Talchir succession. However, AHMAD (1975) who studied the Talchir sediments in detail and considered the bed underlying the marine fossil bed of GHOSH (*loc. cit.*) to represent a typical tillite, considered the marine fossil bed as Upper Talchir and equated it with that of Umaria on the basis of lithological similarities. AHMAD AND HASHIMI (1974) have also described striations, flutings and crescentic chatter marks over the granite basement underlying the tillite.

The palynological studies of Hasia nala sediments have revealed two distinct miofloral zones. The older, Palynozone 1, is characterised by the quantitative abundance of the genus *Plicatipollenites* followed by *Parasaccites* and *Potonieisporites* as the subdominants. In the younger, Palynozone 2, *Parasaccites* rises to general dominance while *Plicatipollenites* reduces to subdominance.

The basement rocks in contact with the lowermost bed, the boulder bed, could not be observed in Hasia nala section. Moreover, this basal boulder bed is comparatively less suggestive of a typical tillite. On the other hand, a thick pile of overlying sediments is present in successive order. Palynologically the older part is marked by *Plicatipollenites* dominant assemblage whereas, the younger one is marked by *Parasaccites* dominant assemblage. These two miofloral zones are well defined and have been recorded for the first time to represent progressive succession of miofloras within the Talchir Formation. The palynological assemblage associated with the Talchir sediments in Korba Coalfield (BHARADWAJ & SRIVASTAVA, 1973 ; p. 146, samples 145—134) also tend to show similar zonation. In sample no. 140 of the bore hole NCKB-19 of Korba Coalfield which is a shaly sandstone with pebbles at the base, *Plicatipollenites* (47%) is slightly more than *Parasaccites* (46%) like Palynozone 1, but in samples 138-134 *Parasaccites* establishes the general dominance over *Plicatipollenites* (like Palynozone 2).

LELE (1975,p. 234) while working on the Talchir miofloras of West Bokaro Coalfield indicated the probable existence of two miofloral assemblages in the early and late parts of the Talchir sediments. The mioflora of the Talchir sediments of Jayanti Coalfield has been worked out by LELE AND KARIM (1971) and LELE AND MAKADA (1972). The mioflora associated with or close to the boulder bed (LELE & MAKADA, 1972 ; p. 67, Table II) shows a general dominance of *Plicatipollenites* similar to Palynozone 1 ; while the one associated with shales younger in succession contains a *Parasaccites* dominant assemblage, similar to Palynozone 2 of Manendragarh. Thus, in the Jayanti Coalfield also an overall dominance of *Plicatipollenites* signifies an older aspect. The Talchir assemblages from Mangthar (LELE & CHANDRA, 1973) in Johilla Coalfield are rich in *Rugasaccites* (+40%) and is closely associated with *Potonieisporites*, *Plicatipollenites* and *Parasaccites* and as such apparently does not compare with the assemblages of Manendragarh in details. According to LELE (1975) assemblages from the Mangthar come from sediments lying almost at the Barakar (?Karharbari) junction. The Talchir mioflora described from Goraia, close to Mangthar, in South Rewa Gondwana Basin (POTONIE & LELE, 1961 ; LELE, 1966) is close to the Barakar (or Karharbari) boundary and may be compared with Palynozone 2 of Manendragarh. The mioflora of Talchir sediments of Giridih Coalfield (SRIVASTAVA, 1973) is also rich in *Parasaccites* (40%) and is associated with *Plicatipollenites* (31%) and *Potonieisporites* (5%), a situation close to the Palynozone 2 of Manendragarh. This assemblage is associated with mudstone much above the basement rocks. Palynologically a *Parasaccites* dominant and *Plicatipollenites* subdominant mioflora comparable to Palynozone 2 is reported from the siltstones in the Talchir Formation of Pench-Kanhan Coalfield (BHARADWAJ, NAVALE & ANAND-PRAKASH, 1974). Thus, the *Parasaccites* dominant assemblage (Palynozone 2) has been recorded from the younger sediments of Talchir Formation from a number of areas of the Lower Gondwanas and wheresoever present, indicates a younger aspect.

The Talchir sediments in Hasdo river section are exposed in patches and are comparatively less developed as compared to Hasia nala. The basement rocks are exposed at a number of places in Hasdo river. It has been observed that the characters indicative of the glacial origin of the Talchir sediments are better developed in Hasdo river section. Furthermore, the presence of basement striations, flutings, crescentic chatter marks and clayey boulder bed (AHMAD, 1975 ; p. 479) suggest deposition by a floating ice shelf and grounded ice. Marine invertebrate animal fossils are characteristically associated with the tillite but no palynofossils could be recovered from it. Mioflora equivalent of Palynozone 2 of Hasia nala has been recorded in sample no. MH/5A (exposure no. 2). But in sample no. MH/9 (exposure no. 3), occuring closely above the tillite, a *Parasaccites* dominant assemblage quite different from that of Palynozones 1 and 2 has been found. This assemblage appears to be younger to the Palynozone 2 of Hasia nala. An interesting feature in it is the presence of acritarchs, spinose and nonspinose both, in abundance. Such a high degree of occurrence of acritarchs, and specially the spinose ones, has been recorded for the first time from the Gondwanas of peninsular India. BHARADWAJ AND SINHA (1969) have reported the occurrence of high percentage of acritarchs (nonspinose) in some samples of 165 meters thick Jhingurdah seam of Singrauli Coalfield but these differ significantly in having association with a disaccate dominant mioflora and in the absence of spinose acritarchs.

Qualitatively, Palynozone 1 is represented by eight genera only. It is associated with the older sediments of the Talchir Formation which are glacial or glacio-fluvial in nature. As such, the two aspects together give the impression of a more or less impoverished flora. The Palynozone 2 on the other hand, is represented by eleven genera and thus, slightly more diversified, is usually associated with the younger fluvial sediments of the Talchir Formation. This assemblage has also been recorded from other Lower Gondwana basins. The mioflora of Palynozone 3 is equally diversified as that of Palynozone 2 but appears to be the youngest in the disjunct sequence. Its comparable has been recorded from samples 114 to 101 in NCKB-19 of Korba Coalfield (BHARADWAJ & SRIVASTAVA, 1973).

The recognisable differences of qualitative and quantitative nature between the three miofloral zones have an apparent correlation with the changing climate during the Talchir sedimentation, which commenced with adverse cold glacial phase but subsequently ameliorated to cool, temperate conditions in the younger phases. Plant life coexisted in a restricted manner under the glacial and glacio-fluvial conditions (Palynozone 1) and continued so till the deposition of shales later. All the three assemblages contain very low pteridophytic spores suggesting that the climate while being cold was also not humid. Presence of alete spores in shales directly overlying the marine influenced boulder beds especially in Hasdo river section, suggests a marine environment to have continued till that level of sedimentation.

CONCLUSION

The palynological study of the Talchir sediments of Manendragarh area suggests that their deposition occurred in three phases. The succession commenced with the *Plicatipollenites* dominant mioflora having the subdominance of *Parasaccites*, *Virkkipollenites* and *Potonieisporites* (Palynozone 1). In the younger phase *Parasaccites* attained the general dominance while *Plicatipollenites* declined to subdominance (Palynozone 2). Both the palynozones are well defined in Hasia nala section. In Hasdo River section a still younger mioflora with *Parasaccites* dominance and *Divarisaccus* subdominance (Palynozone 3) has been recorded.

Lithologically, a complete succession of sediments is well developed in Hasia nala while it is only partly so in Hasdo River. Apparently the Hasia nala section may be representing the deeper part of the basin while the Hasdo River sediments appear to have been deposited nearer the margins. The basement is exposed at places and characteristic evidences of the sediments being deposited in a glacio-marine environment are present. The shales in Hasdo River were deposited coincident with the Palynozone 2 of Hasia nala and later.

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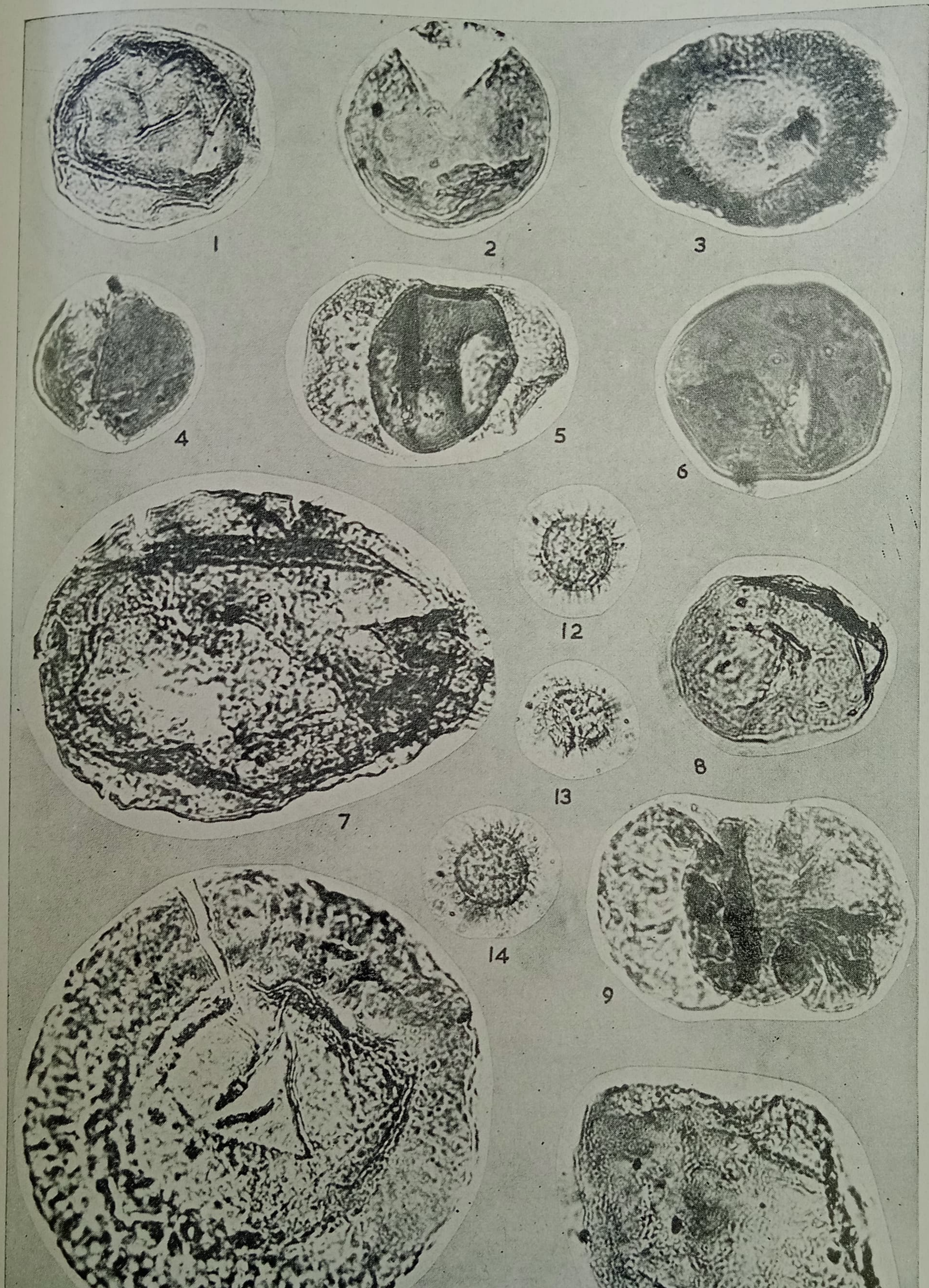

Bharadwaj *et al*.—Plate 1

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EXPLANATION OF PLATE 1

(All magnifications × 500)

1. *Plicatisporis distinctus* Lele & Makada, 1972
2. *Hemisphaerium signum* Hemer & Nygreen, 1967
3. *Parasaccites plicatus* Lele & Makada, 1972
4. *Schizosporis scissus* (B. & H.) Hart, 1965
5. *Limitisporites diversus* Lele & Karim, 1971
6. *Pilasporites calculus* Balme & Henn., 1956
7. *Leiosphaeridia indica* Lele & Chandra, 1972
8. *Leiosphaeridia talchirensis* Lele & Karim, 1971
9. *Striatites* cf. *varius* Kar, 1968
10. *Plicatipollenites indicus* Lele, 1964
11. *Balmeella gigantea* Bose & Maheshwari, 1968

12-14. Spinose acritarchs.