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PALYNOLOGICAL COMPOSITION OF THE BASAL GONDWANA IN INDIA

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ABSTRACT. — Talchir Formation represents the basal Gondwana deposits and commences with the glacial environment. The playnofloras show, in general, the overwhelming dominance of the girdling (radial) monosaccate miospore genera. In the present work, the relative position of each miofloras has been determined, and on the basis of variation analysis, dominance trends as well as the qualitative considerations of the spore-pollen-complex, three zones have been suggested to be existing in the Talchirs.

1. ACKNOWLEDGEMENTS

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2. INTRODUCTION

The Talchirs form the basal depositions of the Gondwana System and consist of boulder-bed at the base, overlain by the khaki green needle shales and the coarse grained standstones. These successions are typified by the characteristic deposition at the Talchir Coalfield, Orissa. These boulder beds, representing the glacial of fluvo-glacial tillite, occur, many a time, in repetition up to four or even more in number. The peninsular boulder beds have their equivalents in the extra-peninsular region also. The Talchir boulder beds, in general, are constituted by a mixture of boulders, pebbles and rock pieces embedded in clay. They are rounded, consisting of gneiss, granite, quartzite, shale, etc. The younger boulder beds, which are found above the needle shale band, contain the khaki shale specks in the matrix as the evidence of reworking. The Talchir shales are greenish-brown, thin bedded and variegated and break up in a pattern of needles hence named « needle shales ». The age of the Talchirs has been variably assessed in the past te be the Upper Carboniferous, Permo/Carboniferous or the Lower Permian.

The present knowledge of the Talchir palynology provides information that the basic nature of the miofloras in boulder beds as well as in the shales, closely resemble with each other by virtue of the dominance of the monosaccate genera. However, little is known about the inter-relationships of these varying assemblages and their relative position in succession. In the present work, therefore, the stratigraphic position of various miospore genera has been evaluated, and the trends of quantitative dominance as well as qualitative occurrence have been determined. All the known miospore assemblages have been re-assessed from this view point. In conclusion, four palynological zones have been identified in the Talchir formation and theid lateral relationships have been established.

3. THE TALCHIR PALYNO-COMPLEXES

On the basis of the palaeontological, lithological and palaeobotanical evidences the age of the Basal Gondwana has been assigned to the Carboniferous by some workers (OLDHAM, 1893; COTTER, 1917; FOX, 1931, HOLLAND, 1933) while to Permian by others (MEDLICOTT & BLANFORD, 1879; VREDENBURG, 1910; REED, 1928; AHMAD & AHMAD, 1962; SASTRY & SHAH, 1964).

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The palynological studies of the Talchir Stage started with the works of VIRKKI (1919, 1946). After a decade and a half, POTONIE & LELE (1961) described a comprehensive account of miospore assemblage from the Talchir beds of South Rewa Gondwana basin. From this date till now, many important contributions by LELE (1964, 1965, 1966), LELE & KARIM (1969, 1971), LELE & MAKADA (1972), LELE & CHANDRA (1972, 1973) BHARADWAJ & ANAND-PRAKASH (1972), BHARADWAJ & SRIVASTAVA (1973) and SRIVASTAVA (1973), have increased the relevant data concerning the Talchir palynology.

Qualitatively there are about 46 miospore genera reported from the Talchir Stage. However, only the monosaccates are more in kind as well as in number, and the general diversification in quality increased in the younger sediments, that means the older miofloras are simple and constituted by a lesser number of genera, the monosaccates being the most important. The following list is given to record the presence of these genera in the Talchir sediments :

Leiotriletes (NAUM.) POT. & KR., 1954.
Callumispora BH. & SRIV., 1969, =*Punctatisporites* (IBR.) POT. & KR., 1954.
Plicatisporis LELE & MAKADA, 1972.
Hennellysporites TIWARI, 1968.
Granulatisporites (IBR.) POT. & KR., 1954.
Lacinitriletes VENK. & KAR, 1965.
Cyclogranisporites POT. & KR., 1954.
Cyclobaculispories (BHARD.) BHARAD., 1966.
Verrucosisporites (IBR.) POT. & KR., 1954.
Lophotriletes (NAUM.) POT. & KR., 1954.
Acanthotriletes (NAUM.) POT. & KR., 1954.
Horriditriletes BH. & SAL., 1964.
Brevitriletes BH. & SRIV., 1969.
Microfoveolatispora BH., 1962.
Jayantisorites LELE & MAKADA, 1972.
Virkkipollenites LELE, 1964.
Plicatipollenites LELE, 1964.
Rugasaccites LELE & MAITHY, 1969.
Parasaccites BHARAD. & TIWARI., 1964.
Tuberisaccites LELE & MAKADA, 1972.
Caheniasaccites BOSE & KAR, 1966.
Divarisaccus VENK. & KAR, 1966.
Crucisaccites LELE & MAITHY, 1964.
Stellapollenites LELE, 1965.
Vestigisporites BALME & HENN., 1955.
Potonieisporites (BHARAD.) BHARAD., 1964.
Rimospora LELE & MAITHY, 1969.
Parastriopollenites MAHESHW., 1967.
Valiassaccites BOSE & KAR, 1966.
Limitisporites LESCH., 1956.
Labiisporites (LESCH.), KL., 1963.
Gigantosporites KL., 1963.
Illinites (KOS.) POT. & KR., 1954.
Platysaccus POT. & KL., 1954.
Vesicaspora (SCHEM.) WILSON & VENK, 1963.
Cuneatisporites LESCH., 1955.
Scheuringipollenites TIWARI, 1973=*Sulcatisporites* (LESCH.), BH., 1962.
Striatopodocarpites (SOR. & SED.) BHARAD, 1962.
Faunipollenites BHARAD., 1962.
Lunatisporites (LESCH.), BH., 1962.
Striatites (PANT) BHARAD., 1962.
Circumstriatites LELE & MAKADA, 1972.
Rhizomaspora WILS., 1962.
Ginkgocycadophytus SAMOIL., 1953.
Pilasporites (BALME & HENN.) TIW. & NAV., 1967.
Quadrisporites HENN., 1958 *emend.* POT. & LELE, 1961.

4. PALYNOLOGY OF THE TALCHIRS

Following is the summary of various quantitative data pertaining to the palynology of the Talchirs. The quantitative results have been given more reliance than the exclusively qualitative records, because of the obvious reasons of relative dominance; however, the qualitative data has also been considered for comparisons.

4.1 **Mohpani Coalfield :**

BHARADWAJ & ANAND-PRAKASH (1972).

II Coal bearing beds :
Scheuringipollenites, Indotriradites, Brevitriletes, Parasacites.

I Slightly carbonaceous Talchir needle shale :
Parasaccites, Virkkipollenites, Plicatipollenites, Callumispora, Scheuringipollenites.

4.2 **Korba Coalfield :**

BHARADWAJ & SRIVASTAVA (1973) : Borehole NCKB-19.

b) Carbonaceous layers :
Callumispora, Parasaccites, Plicatipollenites (*Brevitriletes, Lophotriletes, Horriditriletes* rare but significant by their appearance; disaccate sporadic).

Zone I.

a) Pebbly bed :
Parasaccites, Plicatipollenites, Callumispora, Potonieisporites, Caheniasaccites (disaccate sporadic, Pteridophytic spores absent).

SRISTAVA (1973) : Dhengur nala. Talchir shales.

Parasaccites, Callumispora, Plicatipollenites, Jayantisporites (Brevitriletes, Horriditriletes, Microbaculispora — rare but significant by their appearance).

4.3 **Johilla Coalfield :**

POTONIÉ & LELE (1961) : Gray shales from Goraia :

Parasaccites, Plicatipollenites, Faunipollenites, Quadrisporites, Ginkgocycadophytus, Potonieisporites (apiculates rare).

LELE & CHANDRA (1973) : Greenish Needle shale :

Plicatipollenites (+*Rugasaccites*), *Potonieisporites, Rimospora, Parasaccites; Striatites, Stellapollenites, Punctatisporites* (no apiculates).

Boulder bed :

Plicatipollenites (+*Rugasaccites*), *Potonieisporites, Rimospora, Parasaccites, Punctatisporites* (no apiculates).

4.4 **Umaria Coalfield** (Marine transgression) :

LELE & CHANDRA (1972) : Hard calcareous band (containing rich fauna and plant microfossils) :

Acritarchs+*Parasaccites, Caheniasaccites.*

4.5 **Manendragarh** (Marine transgression) :

LELE & CHANDRA (1972) : Hasia nala (black shale, poor in spores, rich in animal fossils) :

Plicatipollenites, Parasaccites, Potonieisporites, Punctatisporites, Caheniasaccites, Pachysaccus, Faunipollenites (no apiculates; few acritarchs).

4.6 **Jayanti Coalfield :**

LELE & KARIM (1971) : LELE & MAKADA (1972) :

1st and 2nd Boulder Bed and associated shales :

II *Plicatipollenites/Parasaccites, Vestigipollenites (Faunipollenites, Circumstriatites, Apiculatisporis,* varitriletes — rare).

Below the 1st Boulder Bed :

I *Parasaccites, Plicatipollenites, Tuberisaccites, Jayantisporites* (apiculates, varirtiletes and *Callumispora* — rare).

The following palynofloras are only qualitatively known :

4.7 **West Bokaro Coalfield :**

LELE (1966) : Dudhi River; Siltstone just above the boulder bed :

Plicatipollenites, Virkkipollenites, Parasaccites — significant; *Potonieisporites,* apiculates and non striated disaccate — rare; ? Alete — dominant.

4.8 **Giridih Coalfield :**

LELE (1966) Sukhnid river : Needle shale above the boulder bed :

Plicatipollenites, Virkkipollenites — dominant; *Quadrisporites, Punctatisporites,* apiculates, *Potonieisporites, Ginkgocycadophytus* — rare (striated disaccate — very rare).

4.9 **Salt Range (Pakistan) :**

VIRKKI (1946) :

20-25 ft. above the Boulder bed :

II *Plicatipollenites, Virkkipollenites, Parasaccites,* striated and non striated — significant; *Crucisaccites* — rare.

4 1/2 feet above the Boulder bed :

Plicatipollenites, Parasaccites, Virkkipollenites, rare disaccates.

1 1/2 feet above the Boulder bed :

Plicatipollenites; rare disaccates, striated and non striated.

VENKATACHALA & KAR (1968) :

25 feet above the Talchir Boulder ber :

Camptotriletes, Indotriradites, Plicatipollenites, Barakarites, Parasaccites, Cyclofoveolatispores, striated disaccates, *Corisaccites, Hamiapollenites, Ginkgocycadophytus, Decussatisporites; Striasulcites.*

5. PALYNOSTRATIGRAPHIC CONSIDERATIONS

General trends of miofloral occurrence and their relative abundance in the Lower Gond-

wana suggest that in the Talchir Stage the following conditions prevail.

1. The « *Plicatipollenites*-dominance » is an *older tendency* while the « *Parasaccites*-dominance » is a *younger trend* in a sequence.

2. Less diversified flora, the paucity of apiculate spores, and the absence or extreme rarity of saccate pollen is an *older tendency* while diversification in general is an indication of the younger affiliation.

3. The incoming of the pseudo-zonate morphography, the monocolpates and the significance of *Callumispora* (=*Punctatisporites*) incidences are the indication of younger sequencial deposits.

The differences in the general constituents of different miofloras within the Talchirs reflect either a vertical or a lateral variation. Within one succession, where the stratigraphical superimpositions are established, such differences are indicative of the time-gap. The palynological differences between the two widely apart sediments pertaining to this stage may reflect the lateral changes with respect to the established miofloral. In such cases, the constituents are either interchangeable or altogether new. Such considerations, however, must be based on the general trend of variability in the overall miofloral contents.

Table 1 has been composed to show the relative sequence of the known miofloras within the Talchirs. The Johilla miofloras (POTONIÉ & LELE, 1961; LELE & CHANDRA, 1973) appear to be more complete and the older one represents the lower most mioflora in the Talchirs. This is considered to be so, because of the simplicity in the forms, basic nature of monosaccate genera as *Rimospora, Rugasaccites,* etc., absence of trilete apiculated and striated, and the stratigraphical position of the boulder bed (i.e. it is the lowest boulder bed in this region). However, there may be some palynological gap between the Johilla II and the III assemblages.

The Korba assemblages (BHARADWAJ & SRIVASTAVA, 1973; SRIVASTAVA, 1973) have in general, an affinity with the top most miofloras of Johilla, but with a difference. The bottom assemblage of Jayanti Coalfield, with some what more pseudo-zonate spores, has a distinct tendency. This qualitative differences between Johilla and the Jayanti miofloras, apart from the micro-timeplane differences, could be attributed to their being laterally widely apart in the peninsula.

6. THE TALCHIR SEQUENCE OF PALYNOLOGY

The following three zones have been derived from our present knowledge of the Talchir assemblages.

TABLE 1

	KARHARBARI STAGE	*b*) *Parasaccites, Callumispora, Plicatipollenites, Brevitriletes.* *a*) *Callumispora, Parasaccites, Plicatipollenites* (striate and non striate disaccates, apiculates).
TALCHIR STAGE	Zone T-III	*Parasaccites, Callumispora, Plicatipollenites* (apiculates & striates relatively more).
	Zone T-II	*b*) *Parasaccites/Plicatipollenites, Quadrisporites* (striates, *Callumispora, Ginkgosycadophytus,* apiculates — rare). *a*) *Plicatipollenites/Parasaccites, Virkkipollenites* (rare striates, *Jayantisporites,* apiculates, varitriletes and *Callumispora*).
	Zone T-I	*b*) *Plicatipollenites* (+*Rugasaccites*), *Potonieisporites, Parasaccites, Stellapollenites* (apiculates mostly absent but few striate disaccates; *Callumispora*). *a*) *Plicatipollenites* (+*Rugasaccites*) *Potonieisporites, Rimospora, Parasaccites, Punctatisporites* (no apiculates; no disaccates).

In the lowest zone i.e. Zone T-I, the diversification is primitive (slightly more in the b section) and *Plicatipollenites* (pollen with fold system) is in prominance. In the Zone T-II, the *Plicatipollenites/Parasaccites* are inter-balancing, with more of apiculates and pseudo-zonates in T-II a. In Zone T-II b, elements like *Quadrisporites, Ginkgocycadophytus* and apiculated are significant. Zone T-II a and T-II b may represent the interchangeable facies of the same time equivalent units, as is clearly indicated by their composition. The Zone T-III shows more diversification of mioflora with more of *Callumispora* (being second in position) and relatively more striated as well as apiculated. Above the T-III zone, there comes a mioflora characterized by the *Callumispora-Parasaccites-Plicatipollenites* complex. It has been named as the inter-glacial period by BHARJDWAJ (1973) and has been termed to be the part of the Talchir Series. The upper limits of the Talchir Stage assemblages are marked by this phase of *Callumispora* rich zone which again continues in the monosaccates (i.e. *Parasaccites, Plicatipollenites*) and the *Callumispora* rich complex; here the apiculates, saccates and striated increase considerably. The latter phases represent a Karharbari deposit where after a somewhat warmer climate, the relatively cooler conditions have once again set in, but at the same time mioflora has a further diversification. The concept of the Karharbari Stage has been based on the similarity of the plant fossils of this stage and that of the Talchir Stage. Thus, the two stages forming Talchir Series are characterized by similar megaflora. This phenomenon is also true in case of the miofloral sequences. Basically, the strata (carbonaceous shale and coal seams) overlying the Talchir lithological units (i.e. boulder bed, needle shales, sandstone) are to be classified in Karharbari Stage if they contain a *Callumispora,* monosaccate rich mioflora, showing an older affinites in their general contents.

7. DISCUSSION AND CONCLUSIONS

The alete genera do not exhibit that much significance for their abundance as the plant miospores due to their long range and inconsistance occurrence. Therefore, more emphasis has to be laid to the spore-pollen members of the assemblages rather than the alete forms.

The sequence suggested in the above account, accommodates even those miofloras which are known only qualitatively; thus, the Talchir mioflora in the West Bokaro Coalfield (LELE, 1966) finds its place with the Zone T-I b, while thot of the Giridish Coalfield (LELE, 1966) with T-II b. The Salt Range Talchir (VIRKKI, 1946) miofloras from 1 1/2 and 4 1/2 feet above the Boulder bed are allied to the present Zone T-I b. The assemblage which is described from 25 feet above the Talchir Boulder Bed in Salt Range by VENKATACHALA & KAR (1968) is, however, highly diversified and seems to be mixed one, having the Lower Barakar (zonates, monosaccates) to the Upper Barakar (*Hamiapollenites, Barakarites*) elements intermingled in various degrees. Was this a melting pot for all the Barakar basins draining off in the Tethys sea, is a question for future researches, but the mixing is really eye-catching.

The older flora of the Mohpani Coalfield (BHARADWAJ & ANAND-PRAKASH, 1972) reported in a *Carbonaceous* needle shale, contains monosaccate elements in majority. The younger mioflora in the sequence contains *Scheuringipollenites* as a dominant genus. It is opined here that palynologically the Zone-I of this coalfield is Talchir in age while the Zone-II (with 4 sub-zones) belongs to the Barakar Stage. The intermediate strata between the sample No. 4 and 8, measuring about 17 meters, has not yielded any spores (BHARAD. & ANAND-PRAKASH, *loc. cit.*) This could represent the Karharbari Stage but however, the field evidences are absent to support this view. The Zone-I has a monasaccate-dominant flora but without much diversification and therefore its being upper Karharbari age is ruled out. Thus, in this section, it is most probable that the Karharbari sediments have not been deposited.

That the Talchir mioflora had a « continuity of the constituents » with the younger miofloras in Gondwana is very obvious from this analysis. There are, moreover, no important elements of the Carboniferous, significantly present in the Talchirs, which could indicate an older affinity. Doubts may be raised about the genus *Jayantisporites* LELE & MAKADA (1972) to be of a Carboniferous origin but by its pseudo-zonate construction, it is clear that this is a predecessor of the zonate of the Barakar Stage rather than the remnant of the zonate forms of the Carboniferous; moreover the stratigraphical position of this genus within the Talchir also supports this view. It is therefore concluded that the mioflora in the Talchir tillites and the associated beds of the formation is Lower Permian in age.

BALME 11964) has summarized the general sequence of Pre-Tertiary miofloras in Austral-

ian Gondwana. In the Carboniferous mioflora of Australia, which is less diversified and contains « apparently almost entirely pteridophytic » spores, small trilete spores with incipient cingulum with « lycosporoid » constructions are usually present. So far this mioflora has not been reported from India, but the Sakmarian (lower most Permian) mioflora of Australia, shows striking similarity with the Talchir mioflora in having monosaccate genera in abundance. Recently, SEGROOVES (1970) has described some palynological assemblages in the Permian of the Perth Basin, W. Australia. In this succession the lower most miofloras (Sakmarian : Nangetty Formation) named as *Microbaculispora* assemblage, has been found in the sediments of glacial and fluvio-glacial origin. This assemblage — as the name indicates — contains *Microbaculispora tentula* TIWARI, 1965, up to 65 per cent, other constituents being *Punctatisporites, Densosporites* and *Parasaccites.* No such mioflora has been encountered in the Talchir sediments so far. It is strange that in none of the assemblages described by SEGROOVES (1970), the monosaccate is significant in occurrence. This has to be confirmed in other basins too by more work to establish the lateral variation in this continent.

CONCLUSIONS

1. The Talchir palynofloras have been divided into 3 zones on the basis of relative abundance and the trends of diversification of the miospore genera.

2. The Zone T-I has only monosaccate or monosaccoid forms with few *Punctatisporites.* Apiculates are absent. In the monasaccates *Plicatipollenites* is in super dominance.

3. The Zone T-II shows inter-changeability in *Parasaccites/Plicatipollenites.* Diversification increases and the monocolpates, pseudozonates and apiculates change the partners depicting the regional variability.

4. *Parasaccites* finally establishes its supremacy, along with *Callumispora* in Zone T-III. Diversification increases with the incoming of relatively more apiculates and striates.

5. After these zones there has been a reversal of the dominating partners having *Parasaccites* as the sub-dominant genus, an incidence suggestive of a relatively lesser cold phase. Complexity in form and number still increases.

6. This forms a border line for the Talchir/Karharbari palynofloras. Again a cooler climatic period comes which is marked by *Parasaccites,* but this time with a difference i.e. with more triletes, disaccates non-striates and striates and much less *Callumispora*; this characterizes the Karharbari mioflora.

7. Lower mioflora (1 1/2 feet and 4 1/2 feet above the boulder bed) in the Tethys-region (Salt range) resemble with the Zone-I of the peninsular Talchirs but the upper one (25' above the Talchir boulder bed in Salt Range VENKATACHALA & KAR (1968) neither represents Talchir nor Karharbari but a Lower to Middle Barakar affinity with some elements of the Upper Barakar.

8. The average Talchir mioflora from India suggests a vegetational continuity with the younger miofloras of the Lower Gondwana. Palynologically there are no evidence of its Carboniferous relationship and hence a Lower Permian age for Talchirs is supported. A comparison with Australia, in general, indicates a Lower most Sakmarian age for the Talchirs.

9. More of quantitative analysis in Godavari, Satpura basin and Himalayan Talchir is needed to fill the existing gaps in our present knowledge of the Talchirs.

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