PALYNOLOGY OF BIJORI FORMATION (UPPER PERMIAN) IN SATPURA GONDWANA BASIN, INDIA

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ABSTRACT

Bijori Formation, generally equated to the Raniganj Formation (Upper Permian) of Damodar Basin, contains a striated-disaccate dominant mioflora with abundantly represented *Densipollenites* and *Corisaccites-Guttulapollenites* and also some other miospores indicating a Permo-Triassic affinity. In the Lower Gondwana deposits of Indian Peninsula, *Densipollenites*-rich assemblages are characteristic of the coal-less facies towards the close of Raniganj Formation (Upper Permian), but in Satpura Basin comparable mioflora with some definite younger elements seems to exhibit Lower Triassic influence in the Upper Bijoris. By the discovery of this mioflora, the presence of a distinctive assemblage having a Lower Panchet affinity is indicated towards the top of Bijori Formation. There is, obviously, a big scope for similar studies in the whole of Satpura Basin.

INTRODUCTION

THE Gondwana Sequence in the Northern Satpura region (Central India) consisting of fresh water sediments, encompasses the Permo-Carboniferous to Middle Jurassic time span. The Lower Gondwana sediments are exposed in the south of Mahadeva ranges and also in the north, at a number of places along the southern boundary of Narbada alluvium. They have been divided in ascending order as Talchir, Barakar, Motur and Bijori formations.

The Bijori Formation, generally equated with the Raniganj Formation (Upper Permian) of Damodar Valley, is exposed in the area south of the Satpura range (see Crookshank, 1936). Lithologically, the Bijori Formation varies greatly in the characters of its beds as seen along the exposures. They contain olive and buff-coloured clays, sandstones, carbonaceous shales, red and green clays, and massive sandstones. Structural features, e.g. current bedding and ripple marks, are present to show the shallow water conditions of their deposition. Below the Bijoris, Moturs are present without unconformity but overlying them, at different places, are Pachmarhi, Lametas, and Jabalpurs demarcated by unconformity (Crookshank, 1936).

The Bijori Formation, in the south of the Satpura range from where the collection was made, is unconformably overlain by the Pachmarhi sediments (Middle Triassic). Due to a hiatus between the Bijoris and Pachmarhis, it has been assumed so far that the equivalents of the Panchet Group (Permo-Triassic to Lower Triassic) are missing in Satpura Gondwana Basin. But the occurrence of green and red shales, khaki micaceous shales and sandstones in the upper part of the Bijori Formation could not be explained completely as these lithological units are also characteristic of the Panchet Formation in the type area (Raniganj Coalfield) as well as in many other areas of Damodar Basin. In most parts of the Damodar Basin, the Panchet sediments are overlain by the Supra-Panchet sediments which are believed to be equivalents of Pachmarhi Sandstones. Now the question arises whether the early Panchet sediments are represented in the Satpura Basin or not. Have they been eroded away before the deposition of Pachmarhi sediments which is indicated by the presence of an erosional unconformity (Crookshank, 1936)?

At certain places, however, the evidences of erosional unconformity are either lacking or the beds have been deposited almost in regular sequence forming para-conformity. The contact at certain places, such as at the Tawa section — north of Junker Village, has become gradual. These features enhance the possibility of the preservation of the sediments equivalent of the Lower Panchet sediments at some places in the basin. It is an accepted fact that erosion and deposition are complementary to each other, but not represented in the same scale everywhere.

Keeping these possibilities in view, a careful examination of the Sukhtawa Nala Section was made which exposes the younger Bijori sediments. The area near Tawa Dam site (Ranipura), where the Lower part of the Pachmarhi sediments and doubtful Bijori beds are seen, was also traversed.

In view of the lack of lithological differentiation, the age of the upper part of the Bijori sediments can only be decided with the help of palynological studies which have not been attempted, so far, in this area.

STRATIGRAPHIC SUCCESSION

Following is the general stratigraphical succession in the northern Satpura Gondwana Sequence.

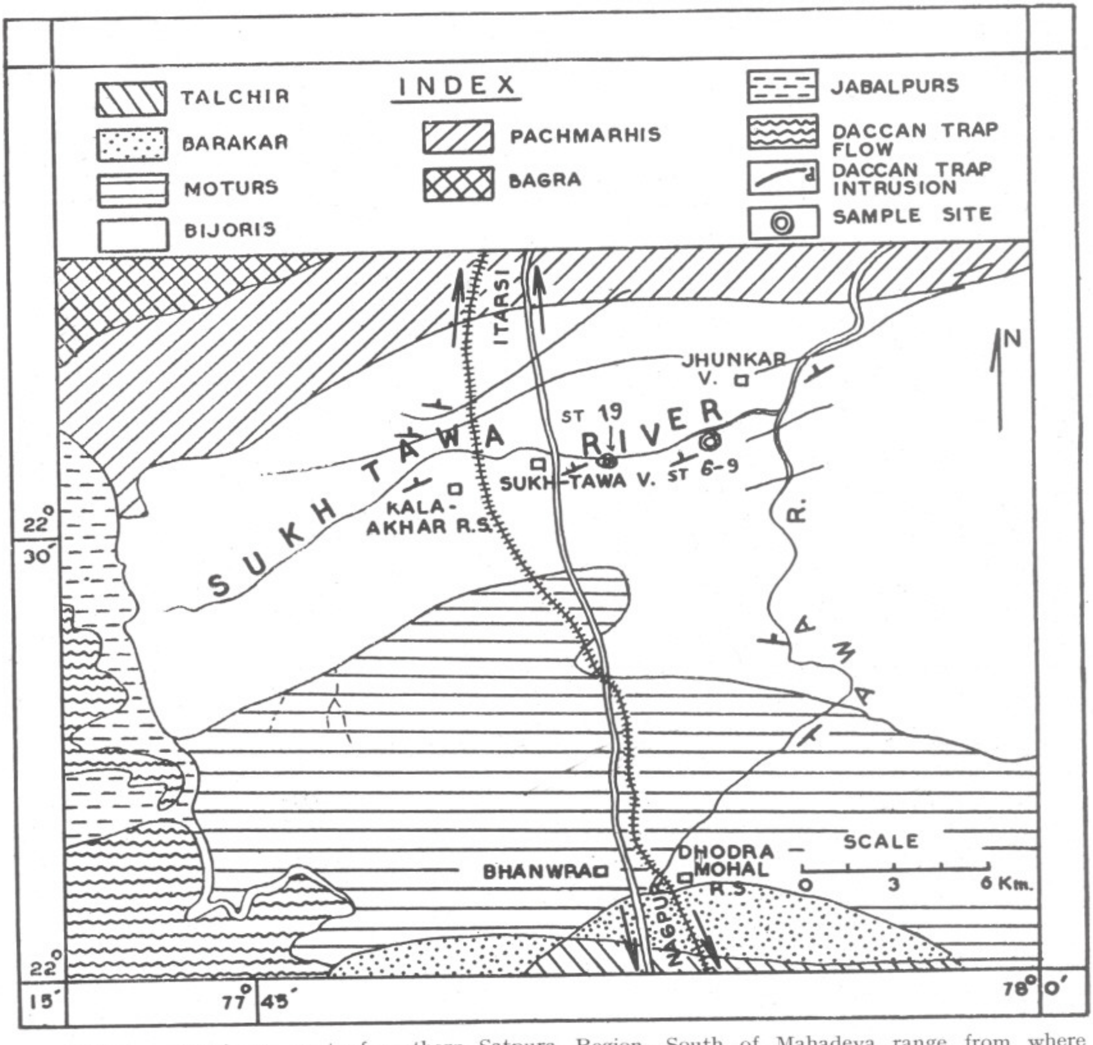
Bagra/Denwa, Pachmarhi } Middle-Upper Triassic

---- Unconformity ----

Bijori, Motur, Barakar, Talchir } Permian

---- Unconformity ----

Metamorphics



MAP 1 — Showing a part of northern Satpura Region, South of Mahadeva range from where the material was collected for palynological study. The sites of sampling denotes only the yielding samples; after Crookshank, 1936. (Read *Deccan* for Deccan).

The material for the present paper comprises samples representing Bijori Formation collected from Sukhtawa Nala. The Sukhtawa Nala, flowing west to east to meet the Tawa River (Map 1), cuts across the EW strike along most of its length and hence, the beds are exposed for a considerably larger stretch without much successional change. The general dip of the beds in the area is northerly at an angle of 5° to 12°. A large number of samples from Ranipura (Tawa-River Dam site) were also collected and macerated but none of them yielded miospores.

The traverse was taken in the upstream direction along the Sukhtawa Nala, from the confluence of the latter with Tawa River, upto the railway line near Kala-Akhar railway station (Map 1). As stated above, the direction of the nala being generally the same as that of the strike, the beds continued to be exposed for quite a distance but due to meandering of the stream sections forming angles with the strike were also available and thus successional sediments were found. The samples collected, thus represent a substantial sequence from younger to the older deposition. Near the confluence of Sukhtawa with Tawa River, whitish coarse-grained sandstones are exposed which are underlain by green sandstone at places having flakes of carbonaceous shales. These sandstones formed the topmost sample of the collection. The sandstones along the section contain interbedded khaki-green needle shales and have a green colour comparable to that of the Talchir sandstone. Similarly, needle shales of khaki-green colour also resemble the Talchir or the Panchet shales of similar colour. Red shales have been observed only at two places (Table 1) as thin bands and so also the carbonaceous shales which vary from 15 to 60 cm in thickness.

Details of samples in descending order are given in Table 1. Approximate positions of the yielding samples, viz., sample nos. ST/6, ST/7, ST/8, ST/9, and ST/19 are indicated in Map 1.

TABLE 1 — DETAILS OF SAMPLES COLLECTED FROM THE SUKHTAWA SECTION

Sample No.	Lithology	Miospore Present (+), Absent (−)
ST/1 (Top)	Sandstone	−
ST/2	Sandy shale in sst	−
ST/3	Red shale in whitish sst	−
ST/4	Red micaceous shale	−
ST/5	Sandy carbonaceous shale	−
ST/6	6-1 Green shale	+
	6-2 Khaki shale	−
	6-3 Grey shale	−
	6-4 Green shale	−
ST/7	Carbonaceous shale	+
ST/8	Khaki shale	+
ST/9	Carbonaceous shale	+
ST/10	Sandy carbonaceous shale	−
ST/11	Khaki shale	−
ST/12	Khaki-greenish shale	−
ST/13	Greenish shale	−
ST/14	Grey shale	−
	14-1 Carbonaceous shale	−
ST/15	Carbonaceous shale	−
ST/16	Carbonaceous shale	−
ST/17	Grey shale	−
ST/18	Greenish shale	−
ST/19	Sandy shale	+
ST/20	Mud shale	−
ST/21	Khaki shale	−
ST/22	Dark green shale	−

PALYNOLOGICAL ASSEMBLAGE

Out of the 22 samples analysed for palynological studies, two samples, i.e. ST/7 and ST/8, have yielded miospores sufficient for quantitative analyses. Lithologically these samples are carbonaceous shales and green shales respectively. Besides, in three other samples, i.e. sample nos. ST/6-1, ST/9 and ST/19, miospores were seen but due to rarity of specimens, bad preservation and the abundance of detritus percentage frequency could not be determined. In spite of the paucity of the yielding samples, these findings are important because no mioflora is known so far from this region and the dating of these rocks is an important problem.

In considering the frequency of miospore genera, the generalized terms for occurrence used here are: dominant $> 25\%$, abundant > 10 to $< 25\%$, common >1 to $<10\%$, rare $<1\%$.

The miofloral composition of the yielding two samples is given below:

	Sample No. ST/7 per cent	Sample No. ST/8 per cent
Dominant		
Striatopodocarpites	44·0	32·0
Common to abundant		
Faunipollenites	17·0	18·0
Densipollenites	11·0	9·0
Corisaccites-Guttulapollenites	2·0	11·5
Common		
Scheuringipollenites	9·5	2·5
Lunatisporites	7·5	2·0
Crescentipollenites	2·5	3·0
Verticipollenites	2·5	2·0
Alisporites	4·0	3·0
Rare to common		
Polypodiidites	—	1·5
Lahirites	0·5	3·5
Hindipollenites	—	2·5
Circumstriatites	—	1·0
Klausipollenites	0·5	1·5

Rare

Microbaculispora, Rhizomaspora, Lophotriletes, Striatites, Brevitriletes, Lundbladispora, Inaperturopollenites, Callumispora.

The *Corisaccites* and *Guttulapollenites* are morphographically allied genera. Their circumscription has been suggested by Balme (1970), although it needs further study. In the present assemblage the majority of the grains belong to *Corisaccites*. However, both the genera have been treated here as a group "*Corisaccites-Guttulapollenites*" for the reason of their uncertain identity.

Chordasporites-like pollen with a medium band have also been found in these assemblages but in the true sense they do not belong to this genus. The apparent structure seems to be secondary in nature and hence, these specimens have been counted along with *Lunatisporites*.

The above break-up of the assemblages suggests that there are certain differences in the palynological components of the two samples. There is, however, a sameness in the percentages of the genera *Striatopodocarpites, Faunipollenites* and *Densipollenites* in these two samples but the *Corisaccites-Guttulapollenites*-complex increases considerably in the younger sample, i.e. sample no. ST/8. In the frequency of other genera, however, the differences are not very significant. In the overall picture, therefore, the two samples do not differ much from each other so as to suggest any major miofloral change between the two. In view of these observations, they have been considered to be variation of a single assemblage (Histogram 1).

Evidently, the striate-disaccate genera contribute more than fifty per cent of the total population in the assemblage. Besides *Densipollenites* and the *Corisaccites-Guttulapollenites* are the genera which are quantitatively well-represented, and at the same time are qualitatively very important. The nonstriate-disaccates are relatively less in number. The taeniate genera, e.g. *Lunatisporites,* are less common but very significant from the point of view of their qualitative values.

During the course of scanning, some miospore specimens were found in sample nos. ST/6-1, ST/9 and ST/19. However, due to the lack of specimens in good numbers as well as good preservation, quantitative analysis of miospore genera in these samples could not be done.

The specimens recorded from these samples have been assigned to different miospore genera as given below:

Sample No. ST/6-1 — Full of spicule-like bodies.

Scheuringipollenites, Densipollenites, Chordasporites, Striatopodocarpites, Callumispora.

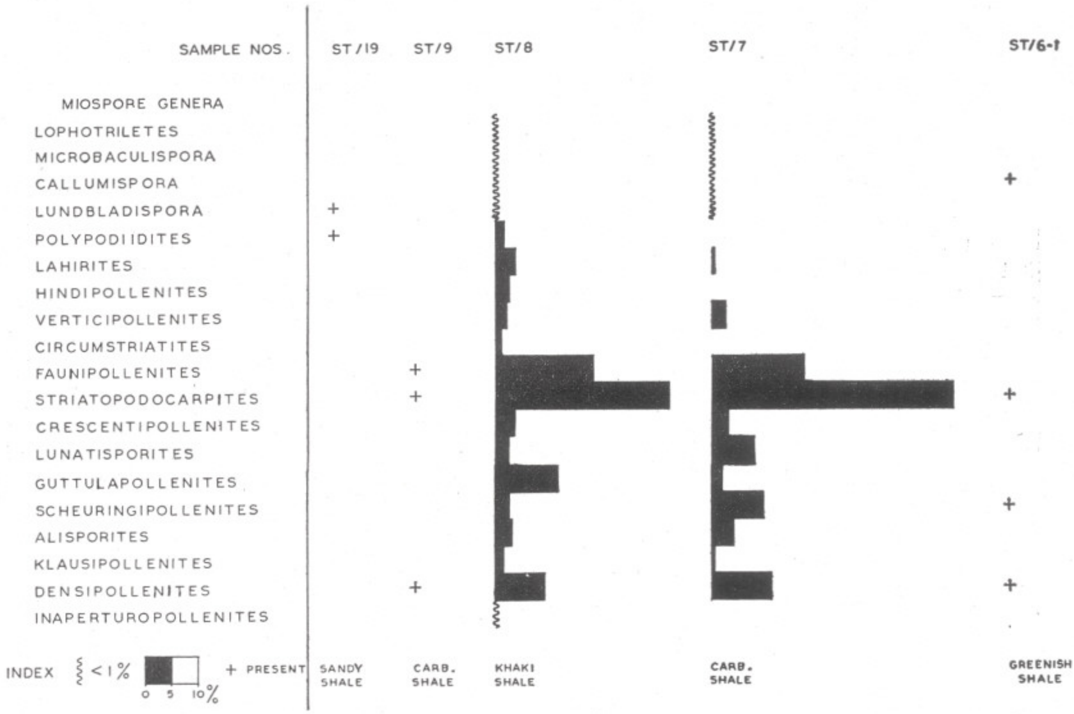
Sample No. ST/9 — Badly preserved specimens.

Densipollenites, Striatopodocarpites, Faunipollenites.

Sample No. ST/19 — Full of wood shreds.

Polypodiidites (many), *Lundbladispora.*

Obviously, nothing conclusive can be said about the palynological composition of the above mentioned samples but it seems probable that sample nos. ST/6-1 and ST/9 contain similar palynoflora as sample nos. ST/7 and ST/8 analysed in detail. Thus, these four samples ST/6 to ST/9 being in continuation exhibit a uniform assemblage. Sample no. ST/19, an older sample in relation to the earlier mentioned four samples, shows a deviation by virtue of the presence of *Polypodiidites* in account-



HISTOGRAM 1 — Percentage frequency of miospore genera in sample nos. ST/7 and ST/8. In samples ST/19, ST/9 and ST/6-1 the preservation as well representation of miospore was poor; the (+) mark indicates the mere record of these genera in these particular samples. (Read *Guttulapollenites* as *Corisaccites-Guttulapollenites* complex).

able numbers. However, lack of detailed analysis of this sample does not allow complete comparison.

AGE OF THE MIOFLORA

The striate-disaccate dominance has been on record from the Upper Barakar, Barren Measure, Raniganj and the Lower Panchet sequences. The present assemblage can not be equated with the first two stages due to the presence of *Lunatisporites*, *Polypodiidites*, *Alisporites* and *Klausipollenites*. The coal bearing strata of the Raniganj Stage (Upper Permian) although compares with the present assemblage, also does not contain the above mentioned genera (Tiwari, 1976). The coal-less beds towards the top of the Raniganj Formation contain, along with the high incidence of striate genera, the genus *Densipollenites* as an abundant form. The comparable *Striatopodocarpites-Densipollenites*-rich assemblages are already known from Nonia Nala (Banerji & Maheshwari, 1974 a, b) Nonia Khal, and Machhkanda Jhor (in Raniganj Coalfield; Bharadwaj, Tiwari & Anand-Prakash, Ms.) and from Gopad River (Maheshwari, 1967).

Considering the miospore pattern, there seems to be an affinity between the above referred assemblages and the Sukhtawa assemblage analysed here. However, it is noteworthy that the *Corisaccites-Guttulapollenites*-complex has never been recorded in abundance from the Raniganj or Raniganj Panchet sediments. Besides, the miospore genera having younger aspect are relatively better represented in the present assemblage than in the other known *Densipollenites*-assemblages. Therefore, the former represents a level close to the top-most beds of the Raniganj Formation or the Raniganj-Panchet transition.

The Triassic assemblages known to have trilete miospores in dominance do not compare with the Sukhtawa mioflora

(Shrivastava & Pawde, 1962; Kar, 1970a, b; Sarbadhikari, 1972; Banerji & Maheshwari, 1974a). The trilete dominance along with the striate-disaccate decline is the indicator of younger horizons in the Panchet Group.

The above discussion clearly indicates that the Sukhtawa mioflora suggests the position of these samples between top-most Raniganj to Raniganj-Panchet transition. However, in view of lithological observations the Sukhtawa mioflora tends to be younger than the *Densipollenites*-rich mioflora of Damodar basin. The latter have been recovered from the grey shales or carbonaceous shales lying well below the khaki-green beds, while the presently studied Sukhtawa samples are themselves khaki-green in colour. This fact is in corroboration with the record of miospores indicating younger affinity in the latter samples and clearly indicates that the present mioflora belongs to the beds of Raniganj-Panchet transition.

The genera *Corisaccites-Guttulapollenites* being in abundance in Sukhtawa assemblage mark a differentiation from other *Densipollenites*-rich miofloras. This deviation, in all probabilities, represents a lateral variation from the Damodar Valley from where rest of the comparable assemblages are known. *Corisaccites-Guttulapollenites* group is also abundant in the Upper Permian of Madagascar (Goubin, 1965), and early to middle Upper Permian of Salt Range (Balme, 1970). Its occurrence, although in rarity, has been recorded from Upper Permian of South Africa (Hart in Goubin, 1965), Upper Permian of India (Kar, 1970b), and Triassic (?) of Australia (Balme, 1970). In Lower Triassic, however, this is a sporadically represented genus.

CONCLUSION

From the preceding account it is concluded that *Striatopodocarpites* dominance and preponderance of the striate-disaccate genera in general, in association with *Densipollenites*, suggests an upper-most Raniganj (Upper Permian) age for this mioflora. The good percentage of *Corisaccites-Guttulapollenites* complex indicates a lateral basinal variation and the presence of *Lunatisporites*, *Polypodiidites*, *Alisporites* and *Klausipollenites* gives a younger aspect to the mioflora, taking it to the Raniganj-Panchet transition. The khaki-green nature of the beds further supports the latter conclusion. This clearly implies that the *Striatopodocarpites-Densipollenites* assemblage has a time transgressive tendency from upper most Raniganj Formation in Damodar Valley to Lower Panchet in the Satpura region of Central India. Such a time transgression is also associated with qualitative change by having *Corisaccites-Guttulapollenites* as new introduction and also by containing more definitive younger elements.

Thus the early Upper Bijoris are now known to contain a mioflora rich in *Striatopodocarpites-Densipollenites* and *Corisaccites-Guttulapollenites* along with younger elements indicating a Permo-Triassic affinity. The findings indicate that the late Upper Bijoris could be equivalent to the Lower Panchet Group. The latter deposits have not been recognized so far, and usually doubted to be missing.

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EXPLANATION OF PLATES

(*All figures are.* × *500*)

PLATE 1

1,2. *Godavarisporites*; Slide nos. 5296.
3,4. *Polypodiisporites*; Slide nos. 5296, 5294.
5. *Callumispora*; Slide no. 5295.
6. *Microbaculispora*; Slide no. 5291.
7. *Lundbladispora* Slide no. 5293.
8,9. *Alisporites*; Slide nos. 5296, 5293.
10. *Scheuringipollenites*; Slide no. 5291.
11. *Klausipollenites*; Slide no. 5296.
12,13. *Densipollenites*; Slide nos. 5296, 5293.
14,15. *Corisaccites*; Slide nos. 5293, 5296.
16. *Guttulapollenites*; Slide nos. 5295.

PLATE 2

17-19. *Faunipollenites*; Slide nos. 5296, 5291.
20. *Crescentipollenites*; Slide no. 5294.
21. *Striatites*; Slide no. 5294.
22. *Verticipollenites*. Slide no. 5293.
23. *Lahirites*; Slide no. 5294.
24. *Lunatisporites*; Slide no. 5292.
25. *Circumstriatites*; Slide no. 5294.
26, 27. *Striatopodocarpites*; Slide nos. 5291, 5291.
28. *Hindipollenites*; Slide no. 5291.
29. *Inaperturopollenites*; Slide no. 5296.

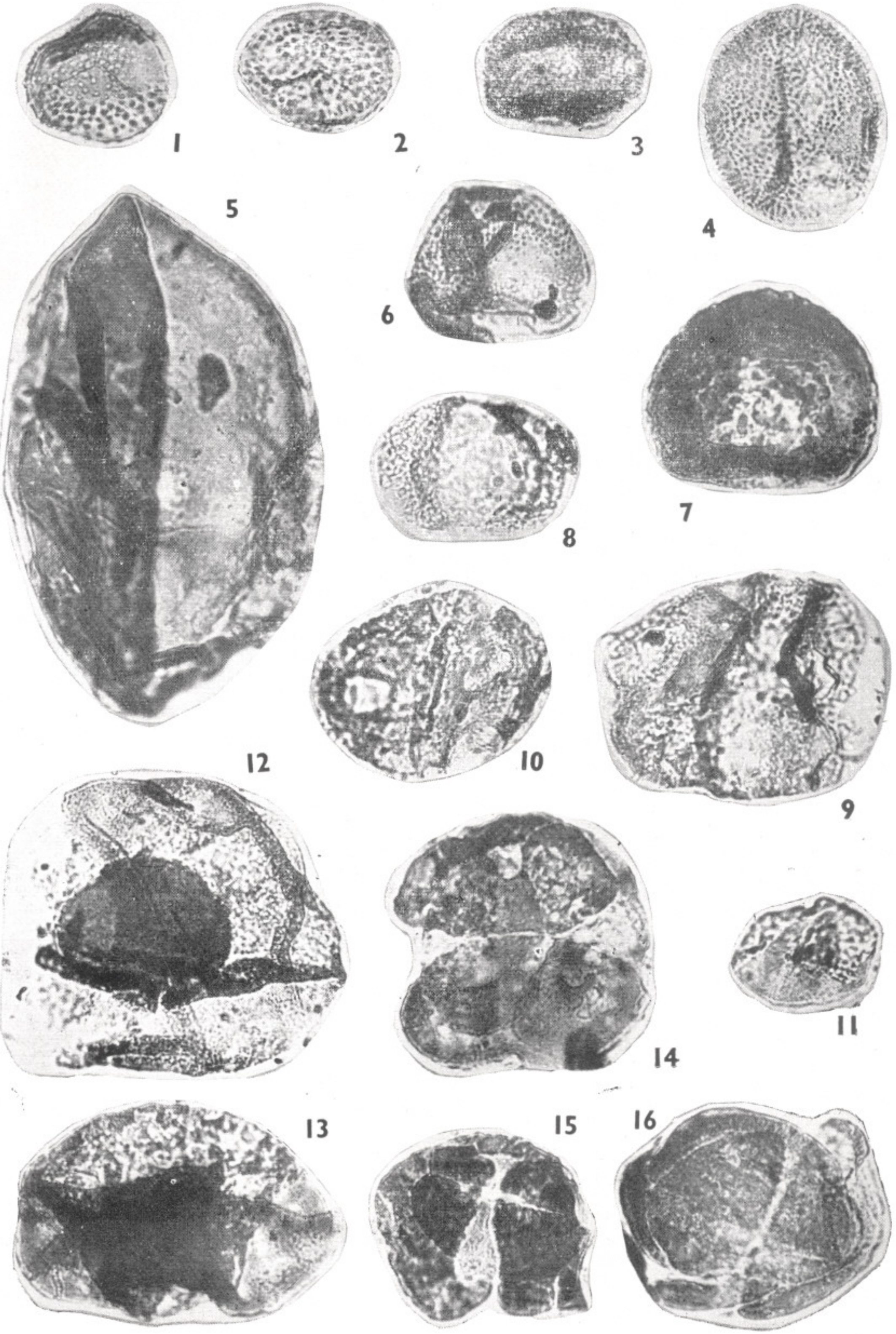

PLATE 1

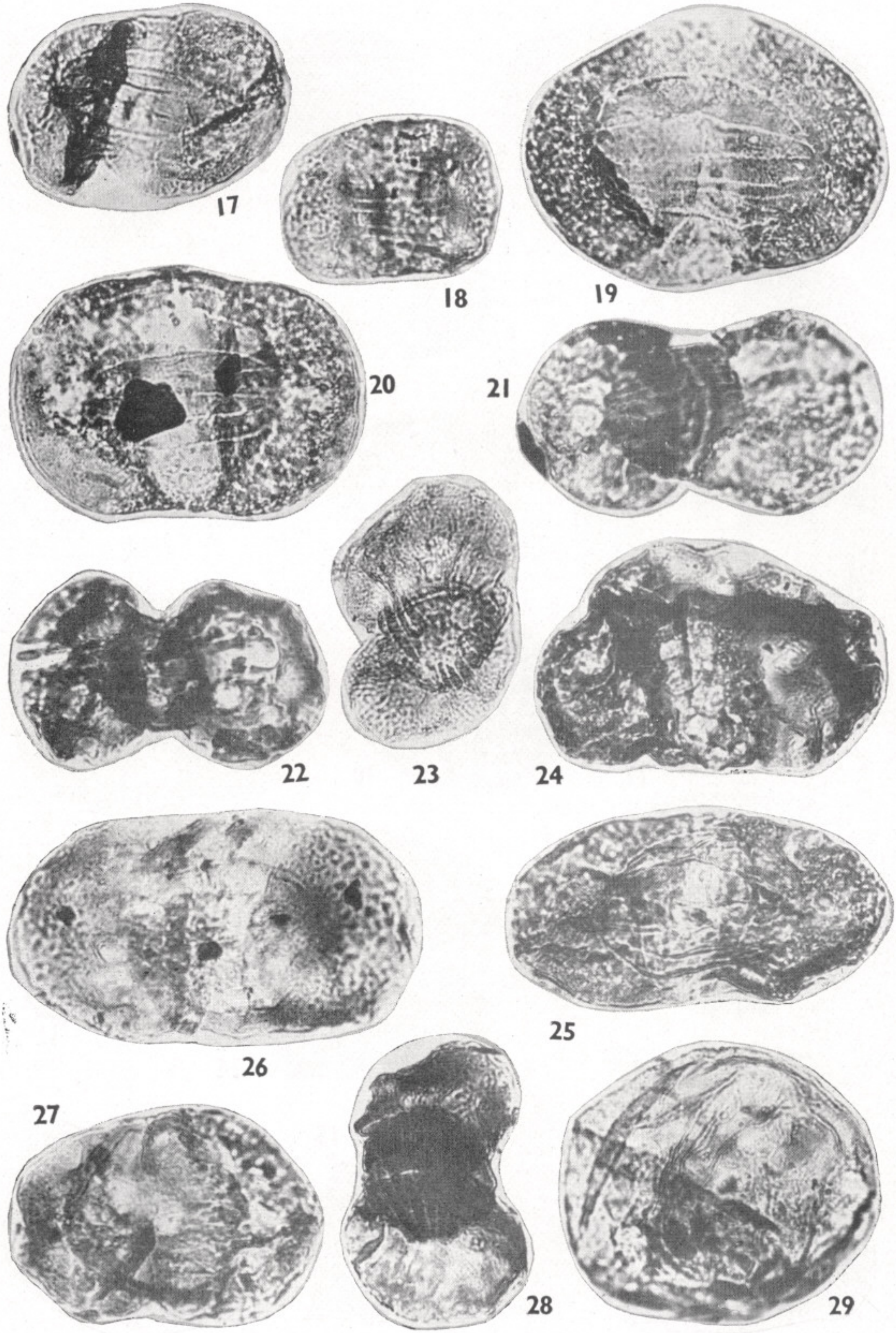

PLATE 2