REAPPRAISAL OF THE MIOFLORA FROM THE JABALPUR SERIES OF INDIA WITH REMARKS ON THE AGE OF THE BEDS

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ABSTRACT

The present paper deals with the sporological analysis (miospore genera) of coals from the neighbourhood of Sehora and Hathnapur in the Jabalpur Series of India which are exposed as the youngest Gondwana strata in the Mahadeo hills of Madhya Pradesh. The assemblage consists of 32 miospore genera, of which the saccate constituent are invariably non-striated. The occurrence of striated and some of the non-striated bisaccates, as reported by Dev (1961), from the Sher river assemblage near Sehora is not confirmed. A comparison of the present assemblage (non Dev, l.c.) with some of those known from comparable horizons from India and abroad has been briefly given. On sporological grounds, it has been inferred that the Jabalpur Series as represented near Sehora and Hathnapur can be successfully distinguished from the Umia beds in Cutch and the Rajmahal Hills in Bihar. The botanical relationship of the dispersed spores with that of the megaflora has been indicated, wherever possible. The reinvestigated mioflora consists of many additional miospore genera some of which viz. *Aequitriradites*, *Rouseisporites*, *Foveotriletes*, *Crybelosporites*, *Cooksonites* and *Contignisporites glebulentus* in conjunction with the megafossil record of *Onchyiopsis* and *Weichselia* strengthen the belief that the Jabalpur Series may conform to Lower Cretaceous age.

INTRODUCTION

THE present paper incorporates revised sporological information (miospore genera) on the coals from the Jabalpur Series (Upper Gondwana) of India and aims to indicate some index fossil forms contained therein. Coal samples have been examined from the Sher river near Sehora and from the Hard river at its confluence with the Sakkur river in the district of Narsinghpur, Madhya Pradesh. Previously Dev (1961) described an interesting assemblage from the same beds near Sehora and recorded some striated bisaccate pollen grains occurring in association with a mioflora almost of the Wealden type. Strikingly enough, this appeared to be quite surprising as striated bisaccate pollen are hitherto not known to occur beyond Jurassic strata. Hart (1964) indicated that if the strata analysed is correctly dated then a younger Jurassic assemblage occurs in India whereas another possibility whether or not the same mioflora could have been reworked also seemed to be attracting. It is in view of these enquiries that an attempt has been made to reassess the miospore composition of the Jabalpur Series. The data presented here are only a cross section of the detailed investigations and have been briefly compared with some other comparable assemblages from the well dated horizons, indicating that the Jabalpur mioflora is in close agreement with those which are known from the Lower Cretaceous age. Pollen grains comparable to the family Magnoliaceae and striated bisaccates as reported by Shrivastava (1954) and Dev (1961) respectively from the Jabalpur Series have not been confirmed.

Geology — The Jabalpur Series are exposed as the youngest Gondwana strata in the Mahadeo hills of Madhya Pradesh, appearing at intervals from South Rewa westwards along the southern side of the Narbada valley, and are seen capping the northern hills of the Satpura. Thin coal seams outcrop at various places but the samples have been collected from the neighbourhood of Sehora and Hathnapur in the district of Narsinghpur, Madhya Pradesh for the present study.

Carbonaceous shales intercalating strings of jet black coal are exposed on the Sher and Machi rivers near Sehora and overlie the usual Jabalpur type strong bed of sandstone. This layer of carbonaceous shales and coals is separated from a similar one by several feet thick beds of sandstone.

The second locality is exposed on the Hard river at its junction with the Sakkur river near Hathnapur, exhibiting the bottom beds of conglomeratic sandstone overlying flaggy sandstone and coaly shales along with jet black coal. This band is in turn overlain by strong beds of sandstone typically of Jabalpur type.

MATERIAL AND METHODS

Coal samples were collected by me from the Sher river (SEHORA) and Hard river (HATHNAPUR) in March, 1962, at an interval of 6-8 inches in each case and were packed in thick brown paper envelopes. The coals are jet black. While sampling, the customary precautions to avoid surface contamination were observed.

The usual maceration technique for these coals proved rewarding. They were treated with nitric acid (commercial) for a week to affect oxidation. The acid free residue after repeated washings with water was digested with hot (simmering) 5 percent KOH solution for about 10 minutes. The washed alkali free macerate was stored in glycerine jelly and slides were prepared in the same medium.

MIOFLORAL COMPOSITION AND ITS COMPARISON WITH SOME OTHER MESOZOIC ASSEMBLAGES

The present mioflora of the Jabalpur Series consists of 32 miospore genera of which 18 are trilete, 2 are monolete, 4 are bisaccate, 1 is trisaccate, 1 is monosulcate, 1 is non-saccate and 5 are alete. This assemblage, obviously records many additional genera, in contrast to the one described by Dev (1961) from Sehora and among these some forms appear to be of definite index value as they are already known to be present only in the Lower Cretaceous assemblages. Those forms which seem to occur exclusively in the Hathnapur coals are marked with an asterisk while others which appear to be individualistic in the coals of Sehora are pointed out in the text. The list of miospore genera occurring in the Jabalpur Series, though not complete as some forms yet await identification, is given below. Descriptions of the dispersed spores and their specific identification are not attempted in this paper.

1. *Cyathidites* Couper, 1953.
*2. *Stereisporites* Pflug, 1953.
3. *Dictyophyllidites* Couper, 1958.
4. *Matonisporites* Couper, 1958.
5. *Gleicheniidites* Ross ex Delcourt & Sprumont emend. Dettmann, 1963.
6. *Verrucosisporites* (Ibraim) Smith *et al.* 1964.
7. *Trilites* Erdtman ex Couper emend. Dettmann, 1963.
8. *Osmundacidites* Couper, 1953.
9. *Conbaculatisporites* Klaus, 1960.
10. *Foveotriletes* Van der Hammen ex Potonié, 1956.
11. *Lycopodiumsporites* Thiergart ex Delcourt & Sprumont, 1955.
12. *Boseisporites* Dev emend. Singh *et al.*, 1964.
13. *Rouseisporites* Pocock, 1962.
14. *Cf. Coptaspora* Dettmann, 1963,
15. *Crybelosporites* Dettmann, 1963.
16. *Contignisporites* Dettmann, 1963.
*17. *Cicatricosisporites* Potonié & Gelletich, 1933
*18. *Aequitriradites* Delcourt & Sprumont emend. Cookson & Dettmann, 1961.
19. *Densoisporites* Weyland & Krieger emend. Dettmann, 1963.
20. *Cooksonites* Pocock emend. Dettmann, 1963.
*21. *Murospora* Somers, 1952.
22. *Leschikisporis* Potonié emend. Bharad. & Singh, 1964.
23. *Laevigatosporites* Ibrahim, 1933.
24. *Araucariacites* Cookson ex Couper, 1953.
25. *Callialasporites* Dev. 1961.
26. *Alisporites* Daugherty, 1941.
27. *Platysaccus* (Naumova) Potonié & Klaus, 1954.
28. *Podocarpidites* Cookson ex Couper, 1953.
29. *Podosporites* Rao, 1943.
30. *Vitreisporites* Leschik, 1955.
31. *Classopollis* Pflug emend. Pocock & Jansonius, 1961.
32. *Cycadopites* Wodehouse emend. Wilson & Webster, 1946.

From the pursual of the above list of miospore genera distributed in the Jabalpur Series of India, it is apparent that the assemblage as it is recovered from the neighbourhood of Sehora does not contain such forms viz. *Todisporites, Concavissimisporites, Lycopodicidites* (=*Iniquiornatisporites*) *Monolites, Saccarisporites, Sehorisporites, Zonalasporites, Circella, Striatites, Protosacculina, Striatopodocarpites, Pityosporites* (in part), *Protopinus, Protoconiferus, Duplicisporites* and *Monosulcites* which were recorded by Dev (1961) from the same locality. On the contrary the following forms viz. *Dictyophyllidites, Matonisporites, Gleicheniidites, Osmundacidites, Trilites, Verrucosisporites, Foveotrilites, Crybelosporites, Densoisporites, Contignisporites, Cooksonites, Leschikisporis, Vitreispo-*

rites and etc. have been recovered from the reinvestigated assemblage of Sehora but they were not previously reported by Dev (*l.c.*). While those forms which appear to be common between the present assemblage and that of Dev (*l.c.*) are *Cyathidites. Lycopodiumsporites, Boseisporites, Laevigatosporites, Callialasporites, Alisporites, Platysaccus, Podocarpidites, Cycadopites, Araucariacites* and *Rouseisporites* (figured as unidentified specimen by DEV, *l.c.* PL. 8, FIG. 67). Among the common forms, except *Rouseisporites*, there is hardly any other element which can be considered as an indicator to date the Jabalpur Series. But from the appended list of miospores, the presence of *Foveotriletes, Crybelosporites, Contignisporites* (particularly *C. glebulentus* Dettm.) and *Rouseisporites* seem to be strikingly significant because their vertical distribution, so far as the author is aware, is limited to Lower Cretaceous strata.

A comparison of the Hathnapur and Sehora (non DEV, *l.c.*) assemblages of the Jabalpur Series reveals that certain miospore genera appear to be characteristic for each of these. For instance, forms like *Conbaculatisporites, Aequitriradites, Murospora* and *Cicatricosisporites* are represented in the former assemblage whereas *Matonisporites, Gleicheniidites, Boseisporites, Osmundacidites* and *Foveotriletes* are confined to the latter. The remaining forms (*See* the list of miospore genera) are common to both these assemblages. Among the individualistic forms represented in the Hathnapur assemblage, the occurrence of *Aequitriradites* and *Murospora* (particularly *M.* cf. *florida*) significantly lend further support to the assumption that the Jabalpur Series mioflora may have a closer agreement with those assemblages which unquestionably conform to Lower Cretaceous age (DETTMANN, 1963). However, it may be pointed out here that the Australian and Indian Lower Cretaceous assemblages (BALME, 1957, DETTMANN, 1963; and SINGH *et al.*, 1964) are much more diverse and complex in their miospore content qualitatively as compared to that of the Jabalpur Series. It also seems necessary to add that the application of characteristically restricted miospore genera occurring in the Hathnapur and Sehora assemblages and their full stratigraphic value within the Jabalpur Series would indeed be better known after the completion of this work. Nevertheless, if the present sporological data are considered in sum total, the index forms contained therein tend to indicate Lower Cretaceous as the estimated age for the Jabalpur Series.

The Umia bed mioflora from the Bhuj Series of Cutch described by Singh *et al.*, (1964), excluding megaspores, has many genera common to the Jabalpur Series. These are *Cyathidites, Matonisporites, Osmundacidites, Lycopodiumsporites, Contignisporites, Boseisporites, Densoisporites, Aequitriradites, Callialasporites, Platysaccus, Podocarpidites, Podosporites, Araucariacites, Cycadopites* and *Classopollis*. Those genera which occur in the Umia beds only and have not been observed in the Jabalpur Series are *Deltoidospora, Alsophilidites, Concavisporites, Lophotriletes* (?), *Trilobosporites* (?), *Cyatheacidites, Crassimonolites, Monolites, Enzonalasporites Microcachryidites, Schizosporis* and *Baculareticulosporis*. On the other hand there are certain forms, viz. *Stereisporites, Dictyophyllidites, Verrucosisporites, Trilites, Conbaculatisporites, Foveotriletes, Cooksonites, Crybelosporites, Murospora, Alisporites, Vitreisporites* and *Rouseisporites*, etc., which are exclusively confined to the Jabalpur Series mioflora but are absent in that of the Umia beds. Thus, from this comparison it seems possible that the Umia beds mioflora can be distinguished from that of the Jabalpur Series on account of the different association of miospore genera in each case although both conform to Lower Cretaceous age.

Sah & Jain (1965) have investigated a miospore assemblage from the Rajmahal Series of India, deducing Bajocian to Oxfordian age for these beds. The generic constituents of this assemblage in common with the Jabalpur Series are: *Cyathidites, Gleicheniidites, Verrucosisporites, Osmundacidites, Lycopodiumsporites, Cicatricosisporites, Callialasporites, Alisporites, Platysaccus, Podocarpidites, Vitreisporites, Podosporites, Araucariacites, Cycadopites* and *Classopollis*. These forms which are considered to be useful in distinguishing the Rajmahal mioflora from that of the Jabalpur Series by their presence in the former and absence in the latter are: *Deltoidospora, Divisisporites, Concavissimisporites, Ceratosporites, Foveosporites, Ischyosporites, Trilobosporites, Phyllocladidites* and *Dacrycarpites*. On the other hand some of the strikingly characteristic examples distributed in the Jabalpur Series but absent in the Rajmahal Series are: *Contignisporites, Crybelosporites,*

Aequitriradites, Densoisporites, Cooksonites, Murospora, Foveotriletes, and *Rouseisporites.* From this comparison it appears that all the index miospore genera of the Jabalpur Series characteristic of Lower Cretaceous age are absent in the Rajmahal hills. Thus on this evidence it is fair to believe that the Jabalpur Series miofloa is distinct from that of the Rajmahal hills and is younger in age.

Vishnu-Mittre (1954), Sah (1953, 1955) and Ramanujam (1957) have given an account of dispersed spores from the Jurassic strata of the Rajmahal Hills, Andigama, Ceylon, Salt Range and East Coast Gondwana of India respectively. All the 4 miofloras, as judged from their respective generic constituents certainly reveal a closer agreement with Jurassic miofloras and do not possess any elements matching with the Lower Cretaceous strata. Recently Srivastava (1963) has published a note on the miofloa from the Jurassic strata of the Rajasthan indicating that it belongs to Lower-Middle Jurassic age. The striking similarity of this assemblage, as observed by its author, with the (?) Jurassic strata of Jabalpur Series seems to be a sweeping statement as the qualitative differences between the two are more apparent than their close relationship.

From the Lower Cretaceous of South east Australia, Dettmann (1963) has put forward a monographic study of the miospores with an account of their stratigraphical and geographical distribution and has recognized three distinct miofloral assemblages namely, the *Stylosus* assemblage, the *Speciosus* assemblage and the *Paradoxa* assemblage on the basis of distinctive species of restricted stratigraphical ranges. She has further observed that this mioflora of S.E. Australia is copiously diversified and contains quite a large number of species which have already been reported in the assemblages of Western Australia (BALME, 1957), Canada (POCOCK, 1962) and Western Siberia (SAMOILOVICH *et al.* 1961) from the comparable horizons. A comparison of the Jabalpur mioflora with that of the S. E. Australia clearly indicates that the former in spite of its being much impoverished, has many genera in common with the latter. Among the common elements, the occurrence of *Cyathidites punctatus, Contignisporites glebulentus, Aequitriradites* sp., *Cooksonites* sp., *Crybelosporites* sp., *Foveotriletes* sp. and *Rouseisporites simplex* in the Jabalpur Series is strikingly noteworthy as they exhibit vertically restricted range (Lower Cretaceous) and yet have a wider geographic distribution either individually or in different associations.

DISCUSSION

The miofloral analysis of the Jabalpur Series attempted in this paper enables me to invoke discussion on the debatable aspect of the age of these Series. Oldham (1893) observed that the Jabalpur beds could be closer in age to the Umia beds than to those of the Rajmahal Hills. On the megafossil record Crookshank (1936) suggested that they are probably of the Oolite (Middle-Upper Jurassic) age and further proposed that the Jabalpur Series could be split up into two stages namely the Jabalpur and the Chaugan stages although the lithology of both is alike. Pascoe (1959) did not agree to this treatment and recognized these two stages as one formation, viz. the Jabalpur Series which is followed in the present paper. Wadia (1953) indicated that the Jabalpur Series pertain to Upper Jurassic age while Matley (1921) opined that they might conform to Lower Cretaceous age on stratigraphical grounds. Bose & Dev (1959) supported the latter view on account of the occurrence of two characteristic wealden ferns namely *Weichselia* Stiehler and *Onchyiopsis* Yokoyama. The area of investigation by these authors was in the neighbourhood of Bansa and Sehora. But in the present case miofloral investigations refer to the coals exposed in the neighbourhood of Sehora and Hathnapur.

The analysis of the palynological data here and particularly its broad based comparison with those assemblages known from the comparable horizons has revealed two important aspects. Firstly, that there are a number of miospore genera which appear in the pre-Cretaceous strata and yet continue their presence in the Lower Cretaceous formations and they are *Cyathidites, Gleicheniidites, Osmundacidites, Cicatricosisporites, Alisporites, Classopollis, Callialasporites, Podocarpidites, Podosporites, Araucariacites* etc. These forms are of no particular stratigraphical significance although they constitute a major proportion of the whole assemblage and remain characteristically associated with the index forms. The index forms, viz. *Contignisporites glebulentus, Aequitriradites, Cooksonites,*

Foveotriletes, *Rouseisporites* and *Crybelosporites* are of significant stratigraphical value because all of them (along with some other miospore genera which are not present here) have a dependable record of restricted distribution in the Lower Cretaceous strata of S. E. Australia (DETTMANN, 1963) and are usually markers of their entry level. They also happen to behave in a similar fashion, if present, either singly or in different groupings in the contemporary strata of W. Siberia (SAMOILOVICH *et al.*, 1961), Western Canada (POCOCK, 1962), Great Britain (COUPER, 1959) and Belgium (DELCOURT & SPRUMONT, 1955). From the hitherto known vertical distribution of these restricted miospore forms and their presence in the Jabalpur Series it would appear beyond doubt that these strata are post Jurassic and may pertain to Lower Cretaceous age thus supporting Bose & Dev's (*l.c.*) contention held on the megafossil record. So far as the finer sporological zonation of the Jabalpur Series is concerned, it is deferred till late date as the qualitative and quantitative data pertaining to the distribution of the miospore species are wanting.

The mioflora of Jabalpur Series is also important in the sense that it distinguishes itself very well from those of the older Rajmahal hills and slightly younger Umia beds of the Upper Gondwana. The feasibility of this fact has been revealed from the detailed comparison among the three assemblages, attempted earlier. The presence of such forms, viz. *Divisisporites*, *Concavissimisporites*, *Ceratosporites*, *Neoraistrickia*, *Foveosporites*, *Phyllocladidites* and *Dacrycarpites* in the Rajmahal hills; *Stereisporites*, *Trilites*, *Conbaculatisporites*, *Crybelosporites*, *Cooksonites*, *Foveotriletes*, *Murospora* and *Rouseisporites* in the Jabalpur Series; *Crassimonoletes*, *Shizosporis* and many megaspore types in the Umia beds are significantly striking for each of the 3 respective assemblages.

Probable relationship of the dispersed spores involved with the corresponding megafossils has been indicated by deducing from the analogy of the spore morphology in the extant forms on the assumption that it also holds good here. Then *Cyathidites* may represent cyatheaceous and dicksoniaceous stock. *Gleicheniidites* may as well correspond to *Gleicheniites*, and *Osmundacidites* to the osmundaceous forms of the megaflora. *Lycopodiumsporites* and *Densoisporites* may have no doubt in reflecting lycopodiaceous content of the megaflora whereas the easily recognizable presence of *Cicatricosisporites* and *Trilites* may be suggestive of schizeaceous element therein. *Leschikisporis* may indicate marattiaceous identity. *Araucariacites*, *Podocarpidites* and *Callialasporites* in all probability seem to have coniferous affinity, of which the first two may represent araucarian and podocarpaceous stocks respectively. *Aequitriradites* and *Rouseisporites* according to Dettmann (1963) seem to have a link with the hepatic species of the megaflora.

CONCLUSION

The present mioflora of Jabalpur Series widely differs from that of the previously described by Dev (1961) from the same locality by the absence of striated bisaccates in total, some nonstriated bisaccates and by the presence of many additional miospore genera. Among these the most important ones are *Contignisporites*, *Aequitriradites*, *Cooksonites*, *Foveotriletes*, *Rouseisporites* and *Crybelosporites* as they reflect a closer relationship of the Jabalpur mioflora with those known from the Lower Cretaceous strata elsewhere. The occurrence of *Onchyiopsis* and *Weichselia* in the same Series provides supporting evidence for this contention. Besides, the Jabalpur mioflora has an identity of its own and is distinct from those of the Rajmahal hills and the Umia beds.

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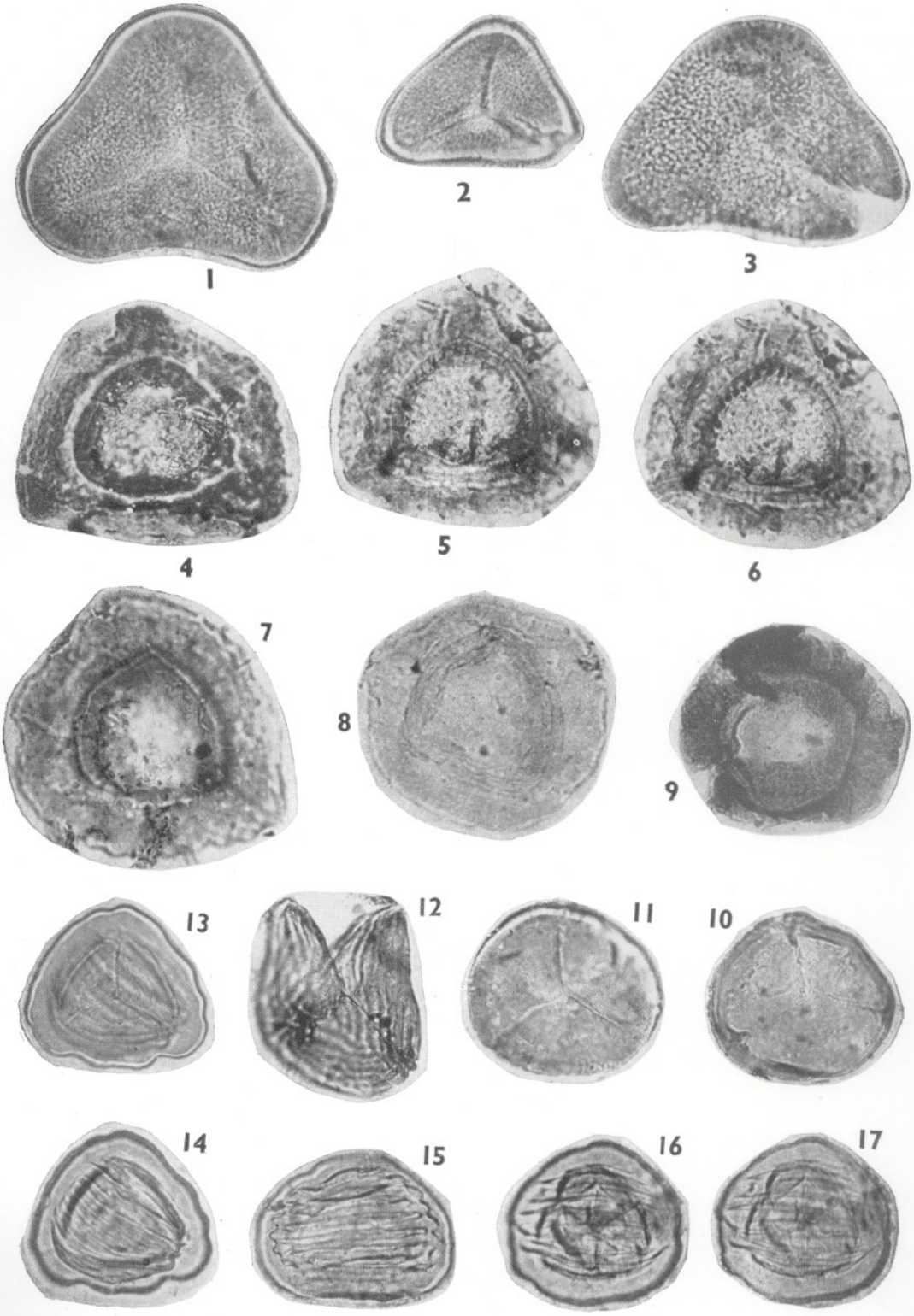
EPXLANATION OF PLATE

(*All figures are from un-retouched negatives and are* × 500.)

PLATE 1

1-3. *Foveotriletes* sp.
4-7. *Aequitriradites* sp.
8. *Crybelosporites* sp.
9. *Cooksonites* sp.
10-11. *Rouseisporites* sp.
12. *Cicatricosisporites* sp.
13-14. *Contignisporites glebulentus* Dettmann, 1963.
15-17. *Contignisporites* sp.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