FURTHER REPORT ON THE FOSSIL MICROFLORA FROM THE MOHGAON KALAN BEDS OF THE MADHYA PRADESH, INDIA

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INTRODUCTION

This paper deals with further investigation of the fossil microflora from the Deccan Intertrappean Series exposed near the village Mohgaon Kalan in the Chhindwara District of the Madhya Pradesh. In continuation of the previous work (Chitaley, 1947, 1950, 1951, and 1951*a*), more pieces of the promising fossil cherts recently collected from the same locality by the author were macerated with HF for further investigation. Clear dehydrated mounts were prepared by passing the material through different grades of alcohol and finally mounting in canada balsam. Some of the preparations were stained with safranin and were found to be better for the microscopic examination.

It is of great interest to have found in this investigation new types of angiospermic pollen grains and pteridophytic spores, not observed in the previous maceration. Pollen grains belonging to Betulaceae, Tiliaceae and Ericaceae have been observed in the present examination. Pteridophytic spores are frequent and resemble those of Gleicheniaceae, Lycopodiaceae, and Polypodiaceae.

It has been found difficult to identify correctly without any hesitation spores and grains in fossilised condition due to indistinctness of structure. To overcome such difficulty and to facilitate the work, it is essential to build up a pollen herbarium for comparison. Nevertheless, a good collection of living pollen described in a handy form like the one published by Su Ting (1949) is very useful for quick reference.

The presence of different types of fungal fructifications in the present maceration is noteworthy. Previously too they were reported (Chitaley, 1947, 1950). Some of the present fungal fructifications are indeed interesting in their resemblance to Microthyriaceous fruit bodies, recorded by others from Tertiary beds (Cookson, 1947, Edwards, 1922). Fructifications resembling those of Pleosporaceae, and Mucoraceae have been also discovered in this investigation. A few types not identified are kept under Incertae sedis. Characteristic cuticles have also been found.

AGE OF THE BEDS

The Deccan Intertrappean Series exposed near the village Mohgaon Kalan was described as Tertiary by Sahni (1934, 1940). However, the Geological Survey of India had previously decided the age of this Series as Upper Cretaceous (Blanford 1869, Medlicott and Blanford 1879, and Oldham 1893).

TECHNIQUE

Hydrofluoric acid was used for the maceration of the fossil cherts. The prepared maceration was washed many times with distilled water to remove

all the traces of hydrofluoric acid. The residue was then treated as follows :

50 per cent alcohol	15 minutes
70 per cent alcohol	12 hours
90 per cent alcohol	15 minutes
Absolute alcohol	Over night
Xylol	5 minutes

After this procedure canada balsam mounts were prepared in the following way :

Thin canada balsam was taken in a small watch glass and the residue from the xylol was transferred to it. After stirring well a drop of the paste was taken on the slide and was spread in a thin film and covered with a cover slip. The preparations prepared with such technique were found to be very clear and devoid of any air bubbles for the microscopic examination. Every possible care was taken to avoid any foreign contamination.

Classification and Nomenclature

For keeping up the continuity with the previous paper in this series (Chitaley 1951*a*), the classification and terminology have been kept the same adopted from the system introduced by Erdtman (1943 and 1947).

Description

The following spores and pollen grains are all measured in μ.

Pteridophytic spores :

Alites

Alites spm. :—(Text-fig. 1, A). Spore spherical, tetrad scar absent; the surface of the spore with thick warts ; 28 μ.

Alites spm. :—(Text-fig. 1, B). Spore spheroidal, tetrad scar not seen ; exine thick, pilatus ; 22 μ.

Monolites

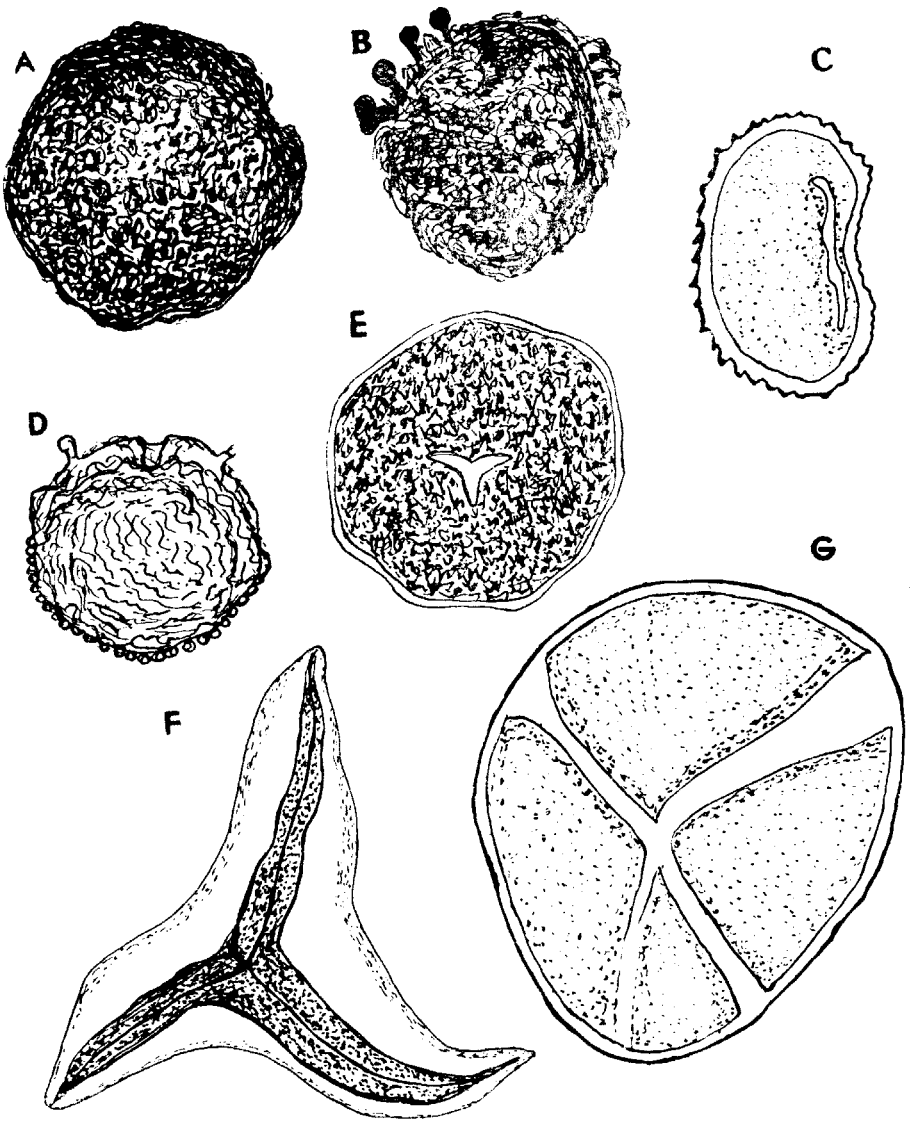
Monolites (*Polypodites*) *spm.* :—(Text-fig. 1, C). Spore concavo convex, monolite, with rough perine present; exposed in lateral view ; 28×18 μ.

Monolites spm. :—(Text-fig. 1, D). Spore spherical, monolite scar shown on the upper side of the figure ; spore wall hairy ; 24 μ.

Monolite spores are generally found in Polypodiaceae (Selling 1946, Naumova 1937, and Erdtman 1943). Potonie and his co-workers (1950) have also described them from miocene and Thiergart (1950) has shown their presence in Tertiary beds. A polypodiaceous naked spore without a perine was described in the previous paper (Chitaley 1951*a*). The present specimen seems to be a spore with perine and may belong to Polypodiaceae.

Triletes

Triletes (*Lycopodites*) *spm.* :—(Text-fig. 1, E). Spore spherical, with thick warty wall ; tetrad scar present ; this type bears a superficial resemblance to that of Lycopodiaceae. Lycopodiaceous spores have been frequently recorded from Tertiary beds (Potonie *et al.*, 1950) ; 33 μ.



TEXT-FIG. 1 :—All figures from A to G are × 1·1.

Pteridophytic Spores.

A. *Alites spm.*
B. *Alites spm.*
C. *Monolites* (*Polypodites*) *spm.* Lateral view.
D. *Monolites spm.*
E. *Triletes* (*Lycopodites*) *spm.*
F. *Triletes* (*Gleichenidites*) *spm.* Triradiate mark prominent.
G. *Triletes spm.* Tetrad scar present.

Triletes (*Gleichenidites*) *spm.* :—(Text-fig. 1, F). Spore triangular, with concave sides and attenuated corners. The triradiate mark is prominent with prominent ridges ; spore wall thick and smooth ; 48 μ.

The present spore bears a close resemblance to that of Gleicheniaceae. Nils-Erik Ross (1949) has shown its presence in the Upper Cretaceous beds of Scania, and Leschik (1955) has reported it from Tertiary beds of Basel. He is not sure about its affinity to Gleicheniaceae.

Triletes spm. :—(Text-fig. 1, G). Spore spheroidal, with prominent tetrad scar, with broad ridges extending and broadening to the periphery; wall of the spore smooth and thick ; 42 μ.

Angiospermic pollen grains :

A number of pollen grains are obtained in the present investigation of the microfloral material. They are of different types. A few of them belong to the monocotyledonous group and the rest are all dicotyledonous.

Monocotyledoneae

Monosulcites spm. :—(Text-fig. 2, H). Pollen grains monosulcate, oblong or boat shaped, with single broad sulcus reaching from end to end; exine thin and smooth ; 24×12 μ.

Monoporites (*Graminidites*) *spm.* :—(Text-fig. 2, I). Pollen grains minute, each one is spherical, with thin smooth wall and one germinal pore surrounded by a poral rim which is approximately 1 μ in width ; size of the grain 12 μ.

Pollen grains belonging to Gramineae were described in the author's previous paper. These grains also may belong to the same family, though differing in size and shape.

Dicotyledoneae

Monocolpites spm. :—(Text-fig. 2, J). Grain monocolpate, oblique equatorial view; elliptical, with thick psilate wall ; the colpa extending from end to end, 36×16 μ.

Tricolpites (*Ericacidites*) *spm.* :—(Text-fig. 2, K). Grains in rhomboidal tetrad ; exine thick with more or less uneven surface ; size of the tetrad, $32 \times 28 \mu$. The grains of Ericaceae are often found in rhomboidal tetrads particularly in the genus *Calluna* ; the present tetrad is very much similar to an Ericaceous one (Erdtman 1943). The importance of the presence of an Ericaceous tetrad in

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EXPLANATION OF TEXT-FIGURES

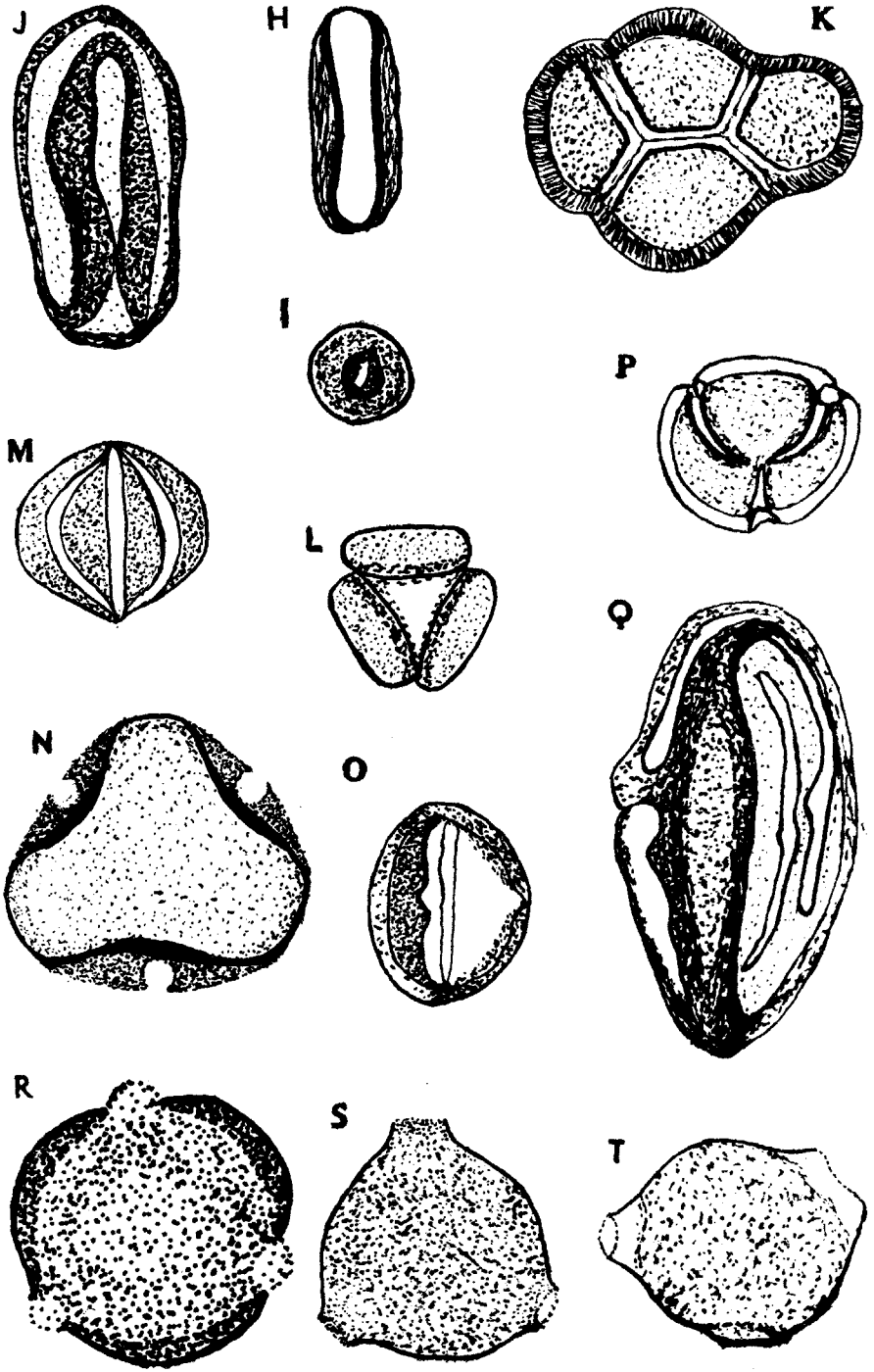
TEXT-FIG. 2 :—All figures from H to T are × 1200.

Monocotyledonous Pollen Grains.

H. *Monosulcites spm.*
I. *Monoporites* (*Graminidites*) *spm.*

Dicotyledonous Pollen Grains.

J. *Monocolpites spm.*
K. *Tricolpites* (*Ericacidites*) *spm.* Rhomboidal tetrad.
L. *Tricolpites spm.* Polar view.
M. *Tricolpites spm.* Equatorial view.
N. *Tricolporites* (*Tiliacidites*) *spm.* Polar view.
O. *Tricolporites spm.* Oblique equatorial view.
P. *Tricolporites spm.* Polar view.
Q. *Tricolporites spm.* Equatorial view.
R. *Triorites spm.*
S. *Triorites spm.*
T. *Triorites spm.*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the present beds can not be ignored. However, Ericaceous grains are very rarely recorded in eocene age and according to Potonie (1951) they have not been reported so far from any of the pre-eocene beds. They have been frequently recorded from Oligocene and Miocene.

Tricolpites spm. :—(Text-fig. 2, L) Grain tricolpate, polar view; wall thin and psilate; 18μ.

Tricolpites spm. :—(Text-fig. 2, M). Grain tricolpate, equatorial view, more flattened in breadth, furrows clear; wall thin psilatus; 20μ.

Tricolporites (*Tiliacidites*) *spm.* :—(Text-fig. 2, N). Grain tricolporate, polar view, faintly triangular; the surface of the grain is rough, furrows short, with appendant germ pores; under an ectexine, there is a mesexine filling. Size 32μ.

The present grain shows much resemblance to a *Tilia* grain described by Kirchheimer (1932).

Tricolporites spm. :—(Text-fig. 2, O). Grain tricolporate, oblique equatorial view; spheroidal; wall thick and psilate, germinal pores present in the furrows; 20$\times$16μ.

Tricolporites spm. :—(Text-fig. 2, P). Grain tricolporate, psilate, furrows deep, narrowing to the centre, germinal pores distinct, one in each furrow; exposed in polar view; 22μ.

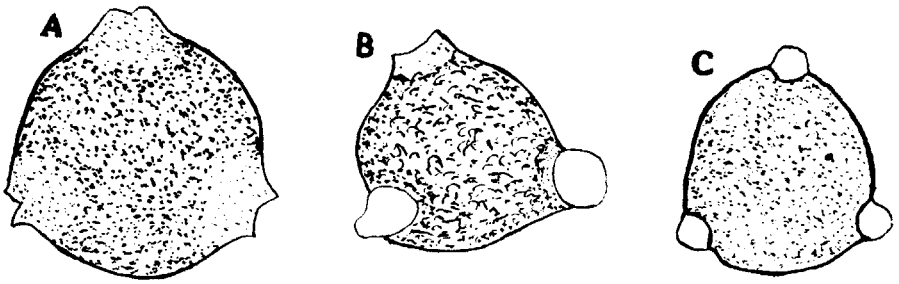
Tricolporites spm. :—(Text-fig. 2, Q). Grain tricolporate, exposed in oblique equatorial view, ovoidal, greater in length than in breadth; wall thick, psilatus, furrows long with germinal pores; 44$\times$24μ.

Triorites spm. :—(Text-fig. 2, R). Grain triorate, spherical, psilate; exine thick of approximately 1μ in width, the pores buldging out; the size of the grain 30μ.

Triorites spm. :—(Text-fig. 2, S). Grain triorate, arci sharp, pores non-aspidate, simple; surface of the grain reticulate, 24μ.

Triorites spm. :—(Text-fig. 2, T). Grain triorate, ores on the two lateral sides are clear; spheroidal; psilate; 24$\times$22μ.

Triorites (*Betulacidites*) *spm.* :—(Text-fig. 3, A). Grain spherical, exposed in polar view, triorate; exine thin, psilate, arci fairly well developed, with three non aspidate pores; 28μ.



TEXT-FIG. 3 :—*Dicotyledonous Pollen Grains.*

A. *Triorites* (*Betulacidites*) *spm.* Polar view. × 1200.
B. *Triorites* (*Betulacidites*) *spm.* Oblique Polar view. × 1200.
C. *Triorites* (*Betulacidites*) *spm.* Pores aspidate, buldging out. × 1200.

The grain of *Carpinus*, a genus belonging to Betulaceae, very much resembles the present fossil grain.

Triorites (*Betulacidites*) *spm.* :—(Text-fig. 3, B). Grain triorate; exine thin and warty; the two germinal pores bulging out, pores aspidate, arci clear; oblique polar view of the grain; 24μ.

Triorites (*Betulacidites*) *spm.* :—(Text-fig. 3, C). Grain spherical, triorate; pores aspidate, bulging out, arci sharp, exine smooth, surface psilate; 22μ.

Fungi :

Different kinds of fungal fructifications have been also observed in the present maceration. For convenience they are described as type 1, type 2, and so on.

Type 1 :—(Text-fig. 4, A and B). This is a shield shaped fruit body with radial structure, dark brown in colour. The margin of the body is sinuous; each fruit body consists of number of slender hyphae, radially arranged; the cells are cubical, dense in the centre, stoma absent; one or two mycelial hyphae are seen attached to the body in the present specimen. Size of the fruit body about 130μ in diameter.

This specimen bears a close resemblance to the fruit bodies of the sub family Asterineae of the Microthyriaceae fungus. Although the present specimen is lacking in complete mycelium, yet its remains are clearly seen attached to the fruit body. It is invariably very difficult to get complete mycelium in fossilised condition when the fruit bodies are not found on the cuticles.

This type of Microthyriaceous ascomata has been already described by Edwards (1922) from Eocene beds and by Cookson (1947) from Oligo-Miocene beds.

Type 2 :—(Text-fig. 4, E). Stalked multicellular fruit bodies have been also observed. Each body is composed of 14–15 cells. Size of each fructification is 75μ in length without stalk and the size of the stalk is 37μ in length. This type of fructification shows a superficial resemblance to that of *Alternaria* or *Rivularia* type of fungus.

Type 3 :—(Text-fig. 4, H and I). Fungal fruit bodies are frequently met with in the maceration. Formation of a zygospore by the fusion of the two different hyphae is obvious though the gametangial ends alone are seen to be present. It looks as if the zygospores are broken off with the gametangial ends and a few cells, from the main hyphae. The zygospore is round and its contents are darker than those of the gametangial ends of the hyphae. Size of the zygospore about 15μ, width of each gametangial end about 9μ. The hyphae which bear gametangia are septate. These fructifications very much resemble those of Mucoraceae except the septate nature of the hypae which is very much unlikely to be found in Mucoraceae.

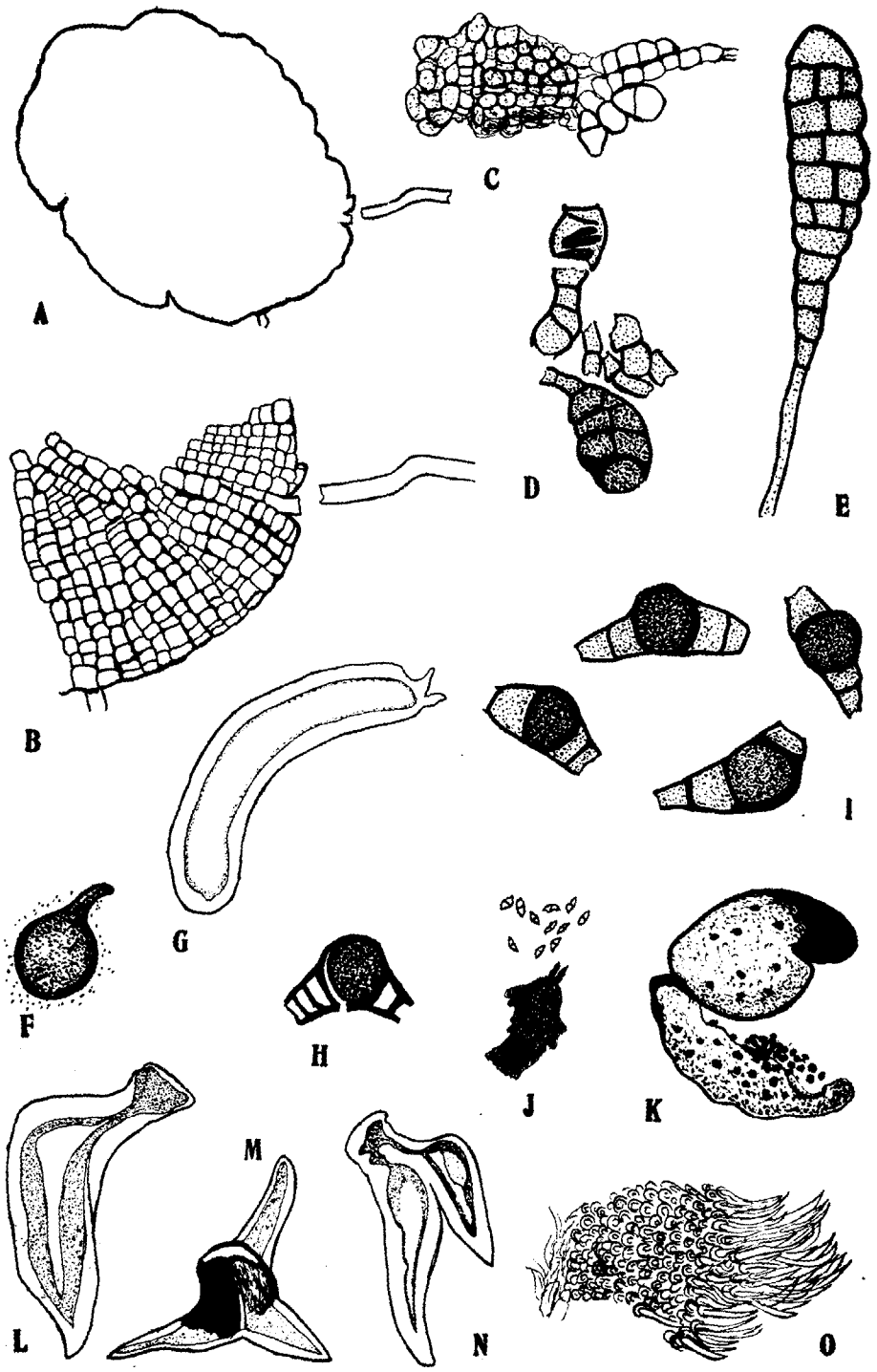
Type 4 :—(Text-fig. 4, D). A number of fungal hyphae are found together. Each one is septate, and breadth of each cell is about 6μ. Interspersed with these hyphae are stalked fruit bodies. Each body is multicellular and 25μ in length.

These fructifications look very much like the muriform spores of the Pleosporaceae, a family of Ascomycetes.

Incertae sedis

Type 5 :—(Text-fig. 4, C). Septate hyphae with small cells have been observed with bicellular bodies intermingled. Size of the cell 5μ. Size of the fruit body in length 10μ.

Type 6 :—(Text-fig. 4, G). Another specimen is a long and narrow small cucumber like structure. The tip is rounded, wall thick and smooth. Size 80μ in length.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Type 7 :—(Text-fig. 4, J). Bicellular minute bodies attenuated at both ends have been grouped together near a number of hyphae which are vertically arranaged in a bundle. The bicellular bodies seem to have come out from these hyphae.

Type 8 :—(Text-fig. 4, F). It is a stalked round body brown in colour, probably a fungus. The stalk is slightly curved. The wall is thick and smooth. The diameter of the body is 26μ and the length of the stalk is about 13μ.

Type 9 :—(Text-fig. 4, K). This is a dark brown spherical body measuring about 50μ in diameter. It looks very much like a dehisced sporangium liberating a mass of spores. The wall at the line of fracture seems to have more thinned down. Nothing can be definitely said since the cell structure is indistinct and the structure of the spores is obscure.

Cuticles

A well preserved cuticle has been also observed in the investigation with the scars of the fallen off hairs. A few hairs are seen still attached. (Text-fig. 4, O). Two types of simple hairs and one type of peltate hair have also been noted. (Text-fig. 4, L, M, and N).

Discussion

The investigation of the fossil microflora from the Mohgaon Kalan beds of the Madhya Pradesh, India, has been recently started by the author (Chitaley, 1947, 1950 and 1951). The present work is in continuation of the previous investigation, and describes more angiospermic grains and fungal fructifications.

Some of the Betulaceae (Erdtman 1951, and Terasmae 1951) grains have been described in the present paper. All of them although belonging to the same family Betulaceae, differ from each other in details which suggest the presence of different species. Identification of these could not be done due to indistinctness of structures in the fossil grains. Pollen grains resembling those of Tiliaceae and Ericaceae have also been observed in this investigation. They have been elsewhere found to be of great importance in determining the age of the bed. The pollen grains of these families have been reported from Tertiary beds by Potonie and Co-workers (1950) and by Kirchheimar (1932). According to Potonie (1951) these grains predominate in late tertiary period, and are found to be very rare in early tertiary. To the author's knowledge they are not recorded so far in the pre-eocene period. Pollen grains resembling those of Compositae were already reported from the same bed in the previous paper (Chitaley

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Explanation of Text-figures

Text-fig. 4 :—

A. *Type 1*, Microthyriaceous fruit body; outline shown × 350.
B. *Type 1*, Portion of the above fruit body magnified showing structural details. × 600.
C. *Type 5*, Incertae sedis. × 600.
D. *Type 4*, Fructifications of ? Pleosporaceae. × 600.
E. *Type 2*, Stalked fruit body of ? *Alternaria* or ? *Rivularia*fungus. × 600.
F. *Type 8*, Incretae sedis. ×600.
G. *Type 6*, Incertae sedis. × 600.
H. *Type 3*, Fruit body like ? Mucoraceous zygospore. × 600.
I. *Type 3*, Fruit bodies ? Mucoraceae, in group. × 600.
J. *Type 7*, Incertae sedis. × 600.
K. *Type 9*, Incertae sedis. × 600.
L, M, N, & O, Cuticles. × 600.

1951*a*). These grains too seem to be restricted to tertiary era. They have not been recorded so far in the earlier periods (Potonie 1951).

Pollen grains of Tiliaceae, Compositae and Ericaceae and fungal fructifications of Microthyriaceae discovered in this investigation have been recorded elsewhere from Tertiary beds (Edwards 1922, and Cookson 1947). They are not recorded to the author's knowledge from pre-tertiary beds. The pollen grains of Myrtaceae, Rosaceae, and Betulaceae, and the spores of Gleicheniaceae, Polypodiaceae, and Lycopodiaceae discovered in these beds have been recorded so far from both Cretaceous and Tertiary beds. It is interesting to note that no particular type of spores and grains is in predominance in the present beds of Mohgaon Kalan of the Deccan Intertrappean Series. Pollen grains and spores recovered from both Cretaceous and Tertiary beds as above have been observed mixed up together. These facts give a vivid picture of the type of the plants growing here in olden times. Both Cretaceous and Tertiary flora seem to have existed side by side. However, the knowledge of the Microflora of the Deccan Intertrappean Beds is too meagre to make any definite statement at this stage of the investigation. Further macerations may show more types of grains and spores and more grains of one and the same type to throw further light on the age of the Deccan Traps.

Recently Rao and Vimal (1955) have drawn a comparison between microflora of the Tertiary lignites from different localities and the microflora of the Deccan Intertrappean Series (Chitaley 1951, 1951*a*), which they have taken as of Eocene age. It is evident from the comparison that types like *monocolpites, triorites* (? *Betula*) *triletes*, are common in both rocks. Also the presence of *Microthyriaceous* fungus in both Tertiary lignites and the Deccan Intertrappean Series is significant. From the present investigation the author would add that the grain of ? *Carpinus* common in Tertiary lignites is also represented in Deccan Intertrappeans. Tiliaceous grains too are represented in both, although the grains present in lignites are different in being *tetracolporites*, and those present in Deccan Intertrappeans being *tricolporites*. Tiliaceae have both these types of grains in different genera. However, more information on the microflora of the Deccan Intertrappean rocks is essential to draw a detailed comparison of the two floras. Similarly, study of the microflora from Indian Cretaceous beds would be helpful for such comparison. Further investigation on both these beds is being carried out by the author at the Government College of Science, Nagpur.

Summary

This paper deals with the investigation of the Fossil Microflora of the Deccan Intertrappean Beds, exposed near the village Mohgaon Kalan, Chhindwara District of the Madhya Pradesh. The investigation of the macerated chert has revealed new Monocotyledonous and Dicotyledonous grains not previously recorded from these beds. The grains of Betulaceae, Tiliaceae, and Ericaceae are worth mentioning. Pteridophytic spores belonging to Gleicheniaceae, Lycopodiaceae, and Polypodiaceae are frequent in the present maceration. Fungal fructifications of Microthyriaceous type and fruit bodies resembling those of Pleosporaceae and Mucoraceae have been also found in these cherts.

It is interesting to note that the pollen grains, spores and fungal fructifications typical of Tertiary age are represented in the present beds in addition to those recorded from both Cretaceous and Tertiary age.

Further investigation of the Microflora of these Deccan Intertrappean beds from Mohgaon Kalan is being carried out, for collection of data which may prove helpful in deciding the age of these beds on the basis of microfloral analysis.

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