PALYNOLOGICAL INVESTIGATION OF THE DHARMSALA SEDIMENTS IN DHARMSALA AREA, KANGRA DISTRICT, HIMACHAL PRADESH

R. K. SAXENA & A. P. BHATTACHARYYA

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

Abstract

A palynofloral assemblage, comprising 14 genera and 25 species, has been described from the Lower Dharmsala sediments exposed along Churan Khad and Manjhi Khad sections in Dharmsala area, Kangra District, Himachal Pradesh. Ten genera and 18 species have been recorded from the Churan Khad section and 9 genera and 11 species (including a new species, *Dicellaesporites himachalensis*) from the Manjhi Khad section. The Churan Khad assemblage is dominated by fungal remains and pteridophytic spores (Schizaeaceae and Parkeriaceae) whereas gymnospermous pollen (Pinaceae) and angiospermous pollen (Potamogetonaceae, Lentibulariaceae and Malvaceae) are subordinately represented. In Manjhi Khad palynoflora, algal and fungal remains and pteridophytic spores (Schizaeaceae and Adiantaceae) are poorly represented whereas gymnospermous pollen (Pinaceae and Araucariaceae) and angiospermous pollen (Liliaceae and Mimosaceae) have comparatively higher incidence. The palynoflora indicates prevalence of tropical to subtropical climatic conditions.

Introduction

The Dharmsala Group is composed of fine to medium grained, grey to purple, compact sandstones intercalated with red, grey, green and purple clays with occasional admixture of sand. The Lower Dharmsala is predominantly argillaceous whereas the Upper Dharmsala is arenaceous. Stratigraphically, Dharmsala Group occupies the same position in Kangra Valley as Murree in Jammu and Dagshai-Kasauli in Simla Hills, and is considered to be their lateral equivalent.

The palynological records from the Dharmsala Group are meagre. Ghosh *et al.* (1963) recorded *Ephedra*—like pollen from this group exposed in Kangra district of Himachal Pradesh. Venkatachala (1972) recorded *Ephedripites*, *Striainaperturites*, *Scabratriporites*, *Pinuspollenites*, *Tetracolporites* and pollen assignable to Chenopodiaceae, Tiliaceae and *Lindsaya* from the Lower Dharmsala (Eocene); and pteridophytic spores of Schizaeaceae, Hymenophyllaceae and Polypodiaceae and pollen of Chenopodiaceae and pine from the Upper Dharmsala (Oligocene—Early Miocene). Mathur and Venkatachala (1979) distinguished Lower Dharmsala from the underlying Subathu Formation by the absence of *Pediastrum*, *Botryococcus* and dinoflagellates. According to them, conifer pollen are uncommon in Lower Dharmsala and angiospermous pollen are more frequent than pteridophytic spores and gymnospermous pollen whereas in the Upper Dharmsala pteridophytic spores and angiospermous pollen dominate over poorly represented gymnospermons pollen. Dogra *et al.* (1985) recorded a palynofloral assemblage from the Dharmsala sediments exposed in a nala cutting near traffic check post of Dharmsala town in Himachal Pradesh. They assigned Early Miocene age to these sediments and interpreted their deposition in a land-protected basin having some coastal communication and moist, subtropical to subtemperate climate.

Good sections of Dharmsala Group are exposed in and around Dharmsala. The present study is based on two such sections exposed along Churan Khad and Manjhi Khad (Text-figs. 1, 2). Thirty samples were collected from the Churan Khad section, of which four samples proved to be productive, whereas 18 samples were collected from the Manjhi Khad, of which seven samples yielded palynofossils. The positions of the

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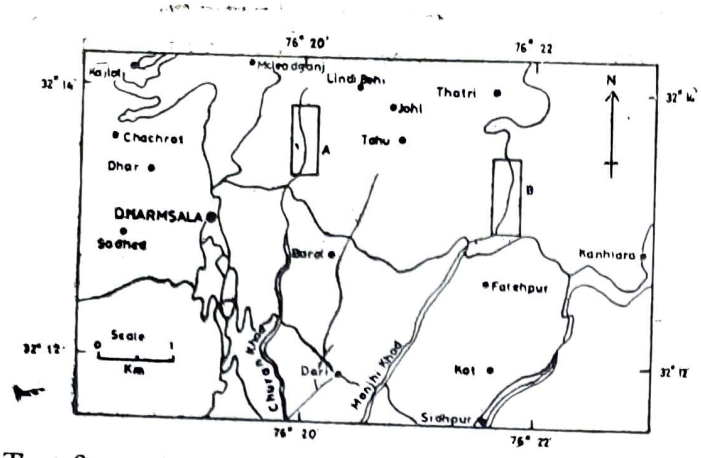


Text-figure 1—Locality map of the Dharmsala area showing the locations of Churan Khad and Manjhi Khad sections. **A.** Churan Khad section; **B.** Manjhi Khad section.

samples are given in Text-fig. 2. The slides and negatives have been deposited in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Systematic Palynology

Genus—*STRIATRILETES* van der Hammen emend. Kar, 1979

Striatriletes susannae van der Hammen emend. Kar, 1979
Pl. 1, fig. 1

Occurrence—Churan Khad and Manjhi Khad sections.

Striatriletes pseudocostatus Singh & Tripathi, 1983
Pl. 1, fig. 2

Occurrence—Churan Khad section.

Striatriletes mediostriatus (Bolkhovitina) comb. nov.
Pl. 1, figs. 4, 5, 8

Basionym—Pelletieria mediostriata Bolkhovitina, 1961, *Trudy Inst. Geol. Acad. Nauk. S.S.S.R.*, **24** : 66, pl. 19, figs. 3a, b, pl. 21, figs. 1a-c.

Occurrence—Churan Khad section.

Remarks—The diagnosis of *Pelletieria mediostriata* Bolkhovitina (1961) conforms with that of *Striatriletes*, hence it is transferred to the latter.

Striatriletes sp.
Pl. 1, figs. 3, 6

Description—Spores triangular with convex inter-apical margins. Size range 53-69 μm. Trilete, rays distinct, unequal in length. Exine 1-1.5 μm thick, costate, costae 1-3 μm wide, branched, laevigate; inter-costal furrows 1-5 μm wide, punctate, puncta uniformly distributed.

Comparison—The present species differs from other species of *Striatriletes* in having punctate inter-costal area.

Occurrence—Churan Khad section.

Trilete spore type—1
Pl. 1, figs. 7, 11

Description—Spores triangular-subtriangular in polar view with convex inter-apical margins and rounded apices. Size range 37-60 μm. Trilete, rays distinct, extending up to the equator, raised. Exine 2-3 μm thick, ornamented with bacula/spine like, 2-4 μm long projections.

Affinity—Adiantum sp.

Occurrence—Manjhi Khad section.

Trilete spore type—2
Pl. 1, figs. 12, 16, 17, 18

Description—Spores triangular in polar view. Size range 46-51 μm. Trilete, rays distinct, extending up to the equator. Exine around contact area darker and thicker than that along inter-apical margins, proximal exine ± laevigate, distal exine ornamented with minute coni/grana, irregular exinal ridges present on distal surface imparting imperfect reticulum.

Occurrence—Manjhi Khad section.

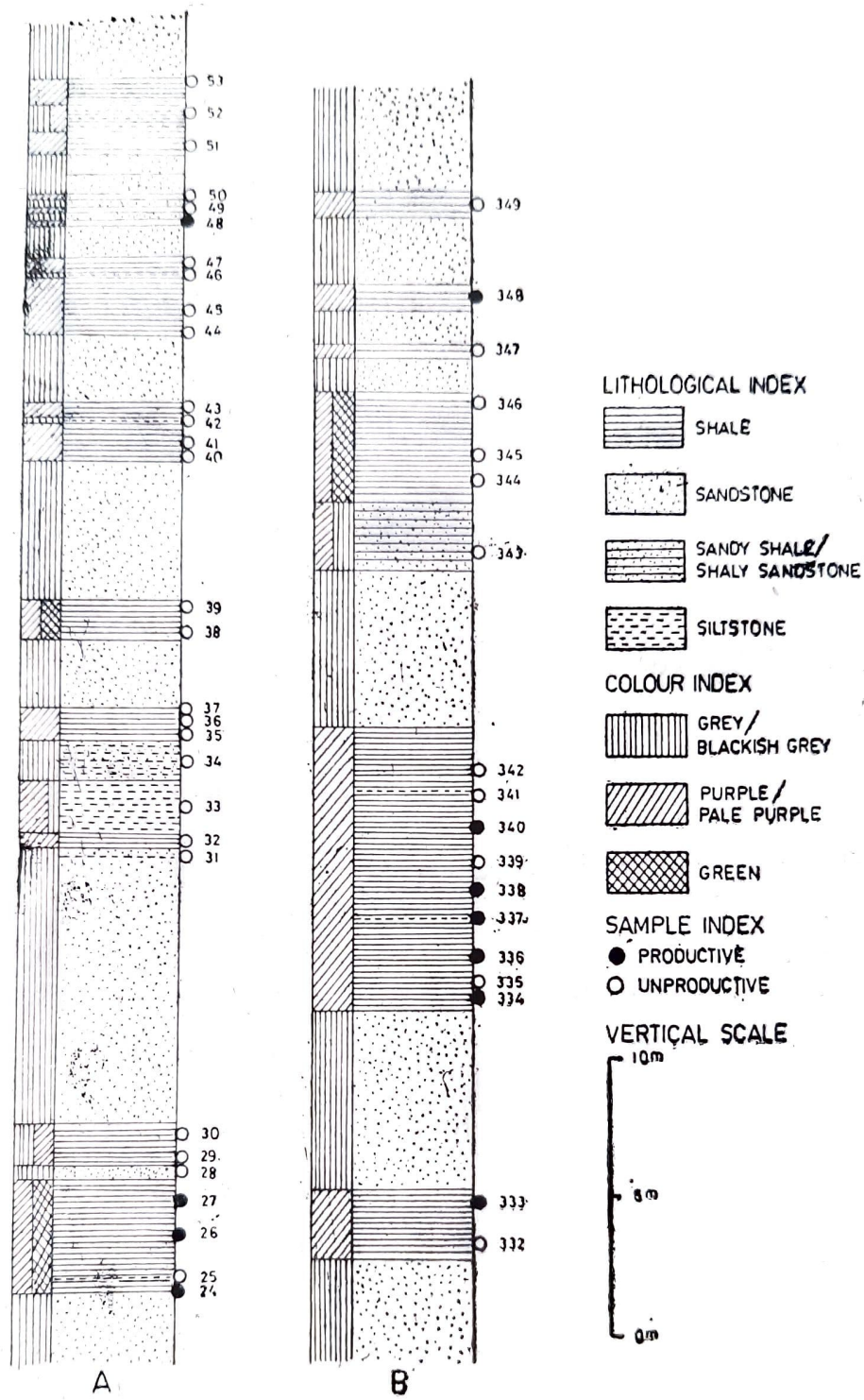
Genus—*SCHIZAEOISPORITES* Potonié, 1951

Schizaeoisporites sp.
Pl. 1, fig. 9

Description—Spores elliptical to bean-shaped. Size range 62-100 × 47-52 μm. Monolete, ray not clearly discernible due to longitudinal striations. Exine 1.5-2 μm thick, striated, striae branched, laevigate, 11-13 in number, 1-3.5 μm wide, furrows between striations 1.5-5 μm wide.

Occurrence—Churan Khad section.

Genus—*LARICOIDITES* Potonié *et al.* ex Potonié, 1958



Text-figure 2—Lithologs of the measured stratigraphic sections showing positions of the samples. **A.** Churan Khad section; **B.** Manjhi Khad section.

Laricoidites magnus (Potonié) Potonié *et al.*, 1950
Pl. 1, fig. 14

Occurrence—Churan Khad and Manjhi Khad sections.

Genus—*INAPERTUROPOLLENITES* Pflug & Thomson *in* Thomson & Pflug emend. Saxena & Bhattacharyya, 1987

Inaperturopollenites hiatus (Potonié) Thomson & Pflug, 1953
Pl. 2, fig. 1

Occurrence—Churan Khad section.
Remarks—The present specimen is bigger

in size (90×72.5 μm) than those recorded earlier by Thomson and Pflug (1953, 30-50 μm) and Wilkinson and Butler (1980, 28-35 μm).

Inaperturopollenites punctatus (Saxena) Saxena & Bhattacharyya, 1987
Pl. 1, fig. 13

Occurrence—Churan Khad and Manjhi Khad sections.

Genus—*ARAUCARIACITES* Cookson ex Couper, 1953

Araucariacites australis Cookson, 1947
Pl. 1, fig. 10

Occurrence—Manjhi Khad section.

Genus—*VERRUALETES* Singh & Saxena, 1984

Verrualetes sp.
Pl. 1, fig. 21

Description—Pollen grain circular in shape. Size 20×18 μm, inaperturate, Exine 1 μm thick, microverrucose-granulose verrucae/grana closely and evenly distributed.
Occurrence—Churan Khad section.

Genus—*LILIACIDITES* Couper, 1953

Liliacidites giganticus Singh, 1977
Pl. 2, figs. 2, 3

Occurrence—Manjhi Khad section.

Liliacidites major Singh, 1977
Pl. 1, fig. 15

Occurrence—Manjhi Khad section.

Liliacidites sp.
Pl. 2, fig. 8

Description—Pollen grain oval. Size 51×45 μm. Monosulcate, sulcus weakly developed. Exine up to 1.5 μm thick, pitted.
Occurrence—Manjhi Khad section.

Genus—*GRANUSTEPHANOCOLPITES* Saxena, 1979

Granustephanocolpites sp.
Pl. 2, figs. 6, 7

Description—Pollen grains circular in polar view. Size range 17-19 μm. Polycolpate, number of colpi eight, brevicolpate (4-5 μm long). Exine 1-1.5 μm thick, granulose, grana evenly distributed.
Occurrence—Churan Khad section.

Genus—*MALVACEARUMPOLLIS* Nagy, 1962

Malvacearumpollis sp.
Pl. 2, fig. 5

Description—Pollen grains circular in shape. Size 76×75 μm. Polyporate, panporate. Exine spinose, spines evenly distributed, conical and projected from a bulging base and tapering into acuminate tips. Pores not clearly discernible.
Occurrence—Churan Khad section.

Genus—*SIWALIKIATHYRITES* Saxena & Singh, 1982

Siwalikiathyrites ramanujamii Saxena & Singh, 1982
Pl. 2, fig. 4

Occurrence—Manjhi Khad section.

Genus—*INAPERTISPORITES* van der Hammen emend. Saxena & Bhattacharyya, 1987

Inapertisporites kedvesii Elsik, 1968

Occurrence—Churan Khad and Manjhi Khad sections.
Remarks—The present specimens are slightly bigger (49-55 μm) in size than those recorded by Elsik (1968).

Inapertisporites ovalis Shelly & Dilcher, 1971
Pl. 1, fig. 19

Occurrence—Churan Khad section.
Remarks—The specimens studied are slightly bigger in size (10-22.5×5-7.5 μm) than those recorded by Shelly and Dilcher (1971).

Inapertisporites ellipticus Chandra *et al.*, 1984

Occurrence—Churan Khad section.

Remarks—The present specimen is 82 × 37 μm in size and has an unfolded psilate spore wall.

Inapertisporites udarii Gupta, 1985

Occurrence—Churan Khad section.

Remarks—The spores recorded here are oval in shape and 65-105 × 57-85 μm in size and have uniformly punctate/foveolate spore wall.

Inapertisporites sp.
Pl. 1, fig. 20

Description—Fungal spores circular, size range 17-20 μm. Inaperturate, unicellate. Wall double layered, 1 μm thick, psilate to reticulate.

Comparison—*Inapertisporites pulvinatus* and *I. vittatus* both instituted by Sheffy and Dilcher (1971) are comparable to the present species in having double layered spore wall, but differ in being different in shape. *I. circularis* resembles in shape and size but has single layered spore wall.

Occurrence—Churan Khad section.

Genus—*DICELLAESPORITES* Elsik, 1968

Dicellaesporites ellipticus Jain & Kar, 1979

Occurrence—Churan Khad section.

Remarks—The present specimen is comparatively smaller (20 × 12 μm) than those recorded by Jain and Kar (1979).

Dicellaesporites himachalensis sp. nov.
Pl. 2, fig. 9

Holotype—Pl. 2, fig. 9, size 60 × 38 μm; Slide no. BSIP 9837, coordinates 6.3 × 105.1.

Type locality—Manjhi Khad section, Dharmsala, Himachal Pradesh.

Type horizon—Lower Dharmsala Formation.

Diagnosis—Dark brown, dicellate, inaperturate, elliptical fungal spore, distinct septa, folds invariably present, size large, spore wall very thick.

Description—Spores elliptical-spindle shaped, dark brown in colour. Size range 53-67 × 31-38 μm. Dicellate, cells distinct, separated by an opaque septum. Inaperturate. Spore wall two layered, 2-2.5 μm thick, psilate-faintly sculptured. Longitudinal fold (s) present.

Comparison—The size of the present fossil spores is much larger than that of *D. popovii* Elsik (1968, 29 × 19 μm). *D. aculeolatus* Sheffy & Dilcher (1971) has small irregular folds. *D. disphaericus* Sheffy & Dilcher (1971) and *D. granuliformis* Sheffy & Dilcher (1971) have pronounced constriction. The present species is distirguished by invariable longitudinal folds, bigger size and thick spore wall.

Occurrence—Manjhi Khad section.

Derivation of name—The specific name is derived from Himachal Pradesh from where the species has been recorded.

Genus—*POLYCEILAESPORONITES* Chandra *et al.*, 1984

Polycellaesporonites bellus Chandra *et al.*, 1984

Occurrence—Churan Khad section.

Remarks—The specimens recorded here are 45-70 × 12-13 μm in size. In some of the specimens vertical septa are not clearly discernible.

Genus—*PEDIASTRUM* Meyen, 1829

Pediastrum sp.
Pl. 2, fig. 10

Description—Coenobium single plate of coenocytes. Size 114 μm. Coenocytes 11 in number and arranged in compact rings, central coenocyte comparatively larger, angular to irregular in shape. Outer coenocyte up to 12 μm high with a blunt, flat tip. Outer cell wall 3 μm thick. Outer cells devoid of pores and angular in shape.

Occurrence—Manjhi Khad section.

Remarks—The present species is distinguished from *P. kajaites*, *P. bifidites* and *P. delicatites*, all described by Wilson & Hoffmeister (1953), in lacking processes and pores. *P. wilsonii* Singh & Khanna (1978) differs in the absence of a central coenocyte. *P. pallidus* Singh & Khanna (1978) resembles in lacking pores but differs in having pear shaped marginal coenocytes with processes.

Palynomorph type—1
Pl. 2, fig. 11

Description—Palynomorphs ± irregular to subtriangular in shape. Size range 75-135 × 38-85 μm. Inaperturate, multicellular, may be a polyad. Individual cells

spherical to polygonal, varying in size. Exine up to 2 μm thick, laevigate, some cells have folded exine.

Occurrence—Manjhi Khad section.

Affinity—*Acacia tarnesiana* has polyads with indefinite number of cells.

Discussion

The palynofloras recorded here from the Dharmsala sediments of Churan Khad and Manjhi Khad sections are represented by 14 genera and 25 species of algal and fungal remains, pteridophytic spores and gymnospermous and angiospermous pollen grains. Of these, only one species, viz., *Dicellaesporites himachalensis* is new. The palynofloras, in general, are quantitatively poor. Of the total 48 samples, only 11 samples proved to be productive with poor recovery of palynofossils.

The Churan Khad palynoflora contains 10 genera and 18 species. The assemblage is dominated by fungal remains and pteridophytic spores whereas gymnospermous and angiospermous pollen are meagrely represented. The fungal remains, contributing 30% of the assemblage are represented by *Inapertisporites kedvesii*, *I. ovalis*, *I. udarii*, *I. ellipticus*, *Inapertisporites* sp., *Dicellaesporites ellipticus* and *Polycellaesporonites bellus*. The pteridophytic spores (56.5%) dominate the assemblage and are represented by *Striatriletes susannae*, *S. pseudostriatus*, *S. mediostriatus*, *Striatriletes* sp. and *Schizaeoisporites* sp. These are assignable to Parkeriaceae and Schizaeaceae. The gymnospermous pollen, assignable to Pinaceae, share 10 per cent of the assemblage and are represented by *Laricoidites magnus*, *Inaperturopollenites hiatus* and *I. punctatus*. The angiospermous pollen contribute only 3.5 per cent of the assemblage and are represented by *Verrualetes* sp., *Granustephanocolpites* sp. and *Malvacearumpollis* sp. These pollen are assignable to Potamogetonaceae, Lentibulariaceae, and Malvaceae respectively.

The Manjhi Khad palynoflora is represented by 9 genera and 11 species. This assemblage, contrary to that from Churan Khad, is dominated by gymnospermous and angiospermous pollen whereas algal and fungal remains and pteridophytic spores are poorly represented. The algae (1.5%) is represented by *Pediastrum* sp., fungi (11.5%) by *Siwalikiathyrites ramanujamii*, *Inapertisporites kedvesii* and *Dicellaesporites himachalensis* and pteridophytic spores (8%) by *Striatriletes susannae* (Parkeriaceae) and trilete spore types 1 and 2 (Adiantaceae). The gymnospermous pollen (41%), assignable to Pinaceae and Araucariaceae, are represented by *Laricoidites magnus*, *Inaperturopollenites punctatus* and *Araucariacites australis*. The angiospermous pollen (38.0%) are represented by *Liliacidites giganticus*, *L. major*, *Liliacidites* sp. and Palynomorph type—1 and are assignable to Liliaceae and Mimosaceae. The present-day distribution of the extant counterparts of the present palynoflora and representation of fungal remains suggest prevalence of tropical-subtropical climate.

Palynofloral Comparison

The Dharmsala sediments, overlying the Subathu (Late Palaeocene to Late Eocene) and underlying the Siwalik (Middle Miocene to Early Pleistocene), have been assigned an Oligocene to Early Mioceneage Fossil records from these sediments are only a few and assemblages are scanty as is also the case with the present assemblages. It has been observed that the present assemblages are not closely comparable with the known Oligocene-Early Miocene assemblages. Absence of bisaccate gymnospermous pollen separates the present assemblages from the Early Miocene palynofloras of Kutch and north-eastern India.

It is interesting to note that the present assemblages do not closely compare with the earlier recorded assemblages from the Dharmsala sediments The differences between the assemblages may be attributed to the disparity in either their stratigraphic position or palaeoecological conditions or both. For example, the assemblage described by Dogra *et al.* (1985) is dominated by gymnospermous bisaccate pollen followed by pteridophytic spores and angiospermous pollen whereas bisaccate pollen are absent from the present assemblages. This difference is due to the disparity in their stratigraphic positions. While the present assemblages are recorded from the Lower Dharmsala, those recorded by Dogra *et al.* (1985) are from the Upper Dharmsala (Early Miocene, Dogra *et al.*, 1985, p. 73, fig. 3). The rich representation of bisaccate pollen in Upper Dharmsala is due to their transportation from the rising Himalayas which might have been sufficiently high to support coniferous vegetation.

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Explanation of Plates

(All photomicrographs are enlarged *ca.* x500, unless mentioned otherwise. Coordinates of the specimens refer to the stage of the Olympus Microscope no. 2058-38).

Plate 1

1. *Striatriletes susannae* van der Hammen emend. Kar; Slide no. BSIP 9819, coordinates 3.0 × 84.9.
2. *Striatriletes pseudocostatus* Singh & Tripathi; Slide no. BSIP 9820, coordinates 14.5 × 98.0.
3,6. *Striatriletes* sp.; Slide no. BSIP 9819, coordinates 10.3 × 92.5, BSIP 9821, coordinates 18.7 × 88.5.
4,5,8. *Striatriletes mediostriatus* (Bolkhovitina) comb. nov., Slide nos. BSIP 9819, coordinates 8.5 × 83.8, BSIP 9822, coordinates 8.5 × 105.6, BSIP 9821, coordinates 6.9 × 97.0.
7,11. Trilete spore type—1; Slide no. BSIP 9823, coordinates 9.1 × 104.6.
9. *Schizaeoisporites* sp.; Slide no. BSIP 9821, coordinates 5.3 × 109.2.
10. *Araucariacites australis* Cookson; Slide no. BSIP 9824, coordinates 18.5 × 92.5.

12,16, 17,18. Trilete spore type—2; Slide nos. BSIP 9825, coordinates 10.0 × 106.8, BSIP 9826, coordinates 11.9 × 93.4.

13. *Inaperturopollenites punctatus* (Saxena) Saxena & Bhattacharyya; Slide no. BSIP 9827, coordinates 3.7 × 93.3.

14. *Laricoidites magnus* (Potonié) Potonié *et al.* Slide no. BSIP 9828, coordinates 6.2 × 88.8.

15. *Liliacidites major* Singh; Slide no. BSIP 9829, coordinates 9.8 × 84.2.

19. *Inapertisporites ovalis* Sheffy & Dilcher; Slide no. BSIP 9830, coordinates 10.5 × 106.9.

20. *Inapertisporites* sp.; Slide no. BSIP 9830, coordinates 15.1 × 88.8.

21. *Verrualetes* sp.; Slide no. BSIP 9831, coordinates 15.7 × 89.5.

Plate 2

1. *Inaperturopollenites hiatus* (Potonié) Thomson & Pflug; Slide no. BSIP 9832, coordinates 11.6 × 90.5.

2,3. *Liliacidites giganticus* Singh; Slide no. BSIP 9833, coordinates 19.9 × 77.0, BSIP 9834, coordinates 13.2 × 93.3.

4. *Siwalikiathyrites ramanujamii* Saxena & Singh; Slide no. 9829, coordinates 13.0 × 93.8.

5. *Malvacearumpollis* sp.; Slide no. BSIP 9835, coordinates 5.5 × 88.4.

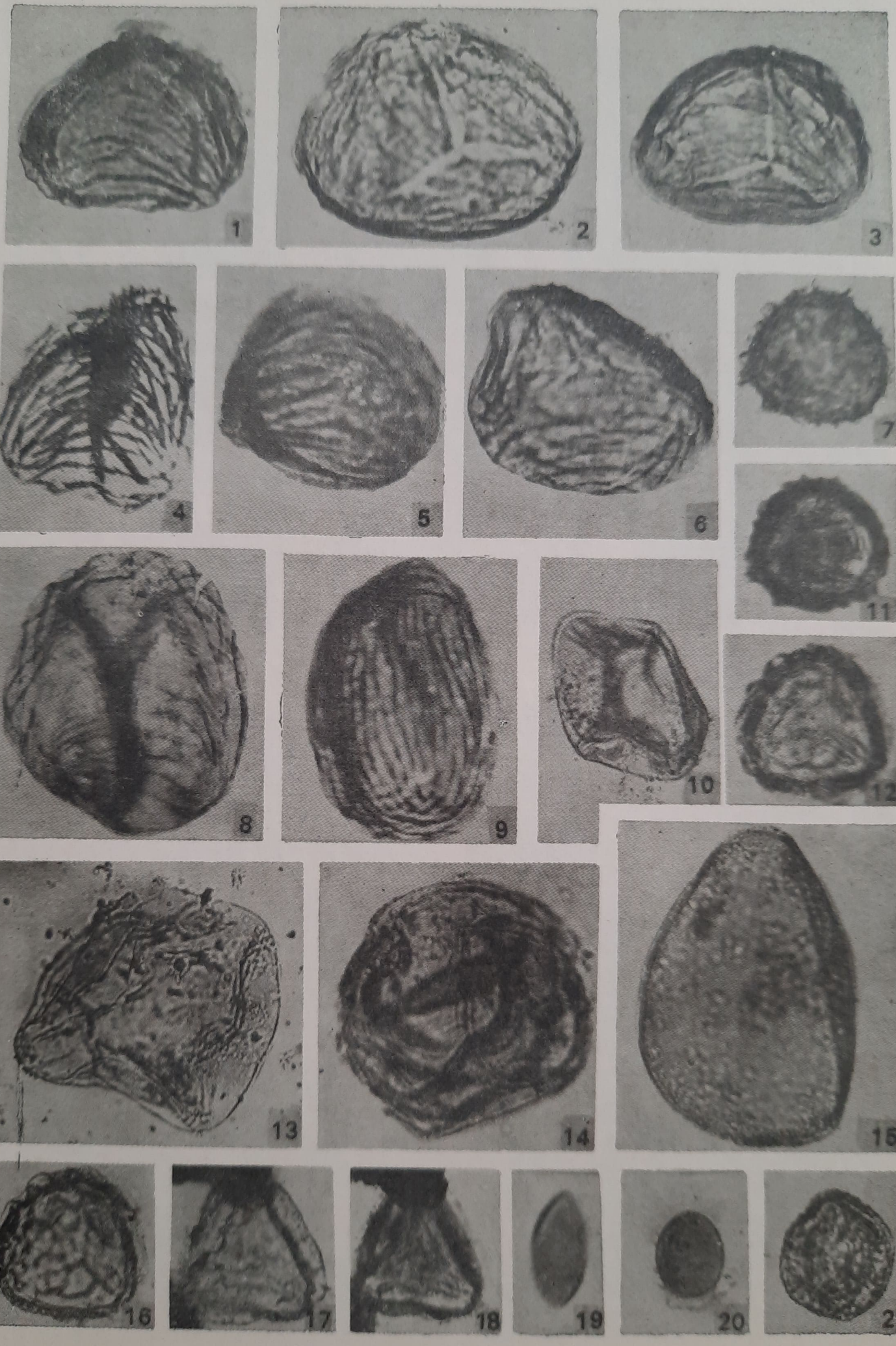
6,7. *Granustephanocolpites* sp.; Slide no. BSIP 9836, coordinates 6.1 × 97.7, BSIP 9830, coordinates 11.5 × 72.2.

8. *Liliacidites* sp.; Slide no. BSIP 9824, coordinates 5.4 × 84.4.

9. *Dicellaesporites himachalensis* sp. nov.; Slide no. BSIP 9837, coordinates 6.3 × 105.1 (Holotype).

10. *Pediastrum* sp.; Slide no. BSIP 9823, coordinates 18.4 × 109.1.

11. Palynomorph type—1; Slide no. BSIP 9833, coordinates 7.9 × 108.2, (× 1100).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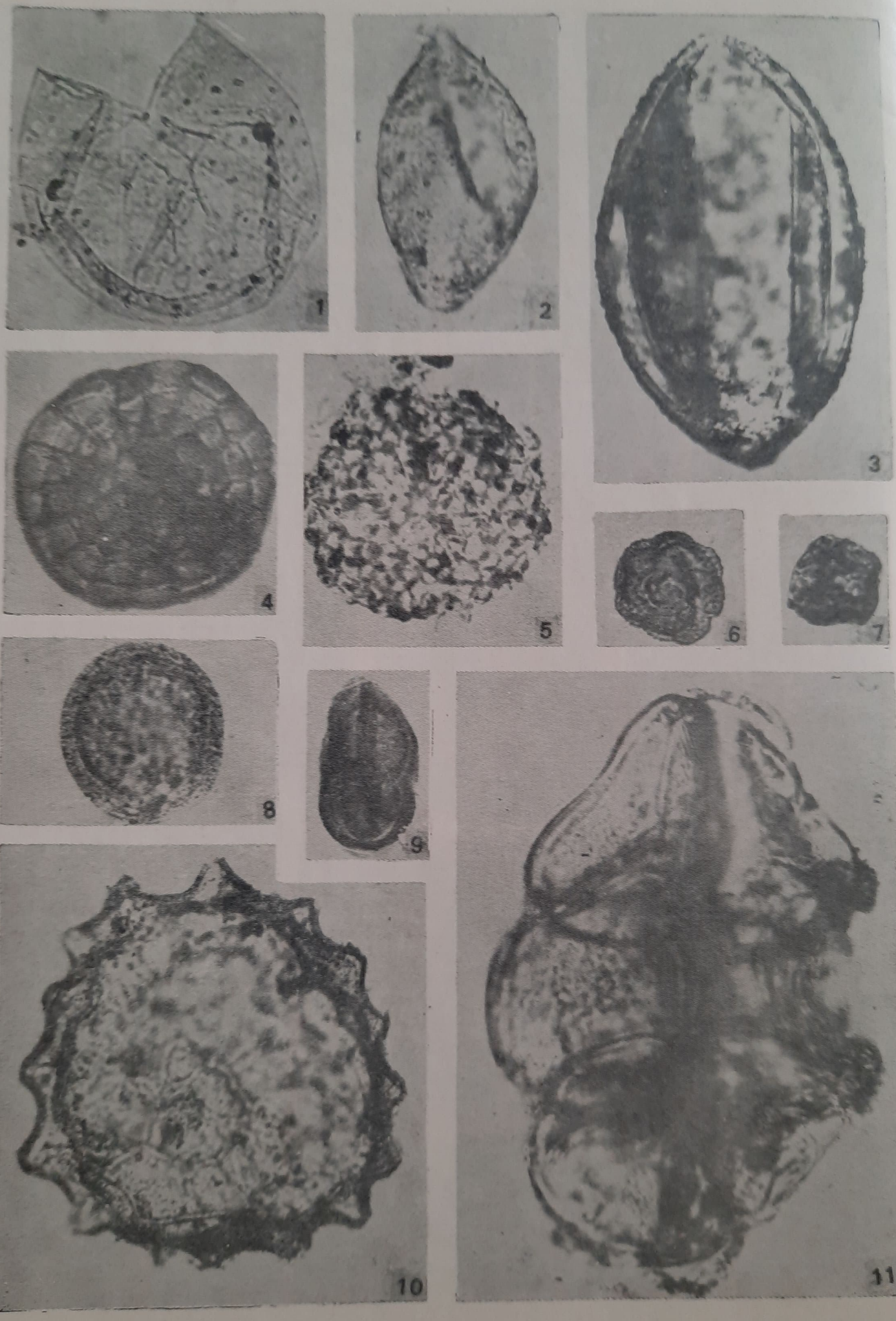

Saxna & Bhattacharyya—Plate 2