

CUTICULAR STRUCTURE AND AFFINITIES OF *CHEIROPHYLLUM LACERATA* (FEISTMANTEL) N. COMB.

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ABSTRACT

A new genus *Cheirophyllum* is made for some lobed leaves which were described earlier by Feistmantel (1886) under the name *Noeggerathiopsis lacerata*, and by Maithy (1965) as *Palmatophyllites lacerata* (Feistmantel) comb. nov. as well as some newly collected identical duplicates from the Karharbari Stage of the Giridih Coalfield. The cuticles of *C. lacerata* (Feistmantel) comb. nov. are also described. It is pointed out that the name *Palmatophyllites lacerata* is illegitimate.

INTRODUCTION

UNDER the name *Noeggerathiopsis lacerata* Feistmantel (1886) and others described some scale-like deeply lobed leaves from Karharbari Stage of the Lower Gondwanas of India. The lobed character of the leaves clearly distinguishes them from leaves of *Noeggerathiopsis* and also from scales attributed to it and to other genera. Doubts about their inclusion in *Noeggerathiopsis* were expressed by Zeiller (1902), Arber (1905) and Pant and Verma (1964). Subsequently, Maithy (1965) included them under a new name *Palmatophyllites lacerata* (Feistmantel) Maithy, and suggested that they are of the nature of megasporophylls. Since, even the drawings and photographs of Maithy's seed-bearing specimens looked rather different from the typical fossils of this species and also because the structural details of *Noeggerathiopsis lacerata* were unknown, we collected some compressed duplicates and studied their cuticular structure. We have also re-examined Feistmantel's type collection in the G.S.I. Museum and the specimens which were attributed to the species by Maithy. The results of our study are embodied in the present paper.

MATERIAL AND METHODS

The compressions of deeply lobed small leaves were collected from the Karharbari Stage of the Giridih Coalfield. External features were studied and photographed under incident light and oil. Cuticles were prepared by maceration of the leaf sub-

stance by the usual Schulze's method and mounted in safranin glycerine jelly. All the slides and specimens figured in this paper are kept in D.D. Pant collection at present located in the Botany Department, Allahabad University.

OBSERVATIONS

Genus — *Cheirophyllum* nov.

Diagnosis — Detached simple leaves, lamina contracted towards base and showing a number of deeply divided narrow lobes on distal side. Veins parallel, non-anastomosing, lobes multiveined. Midrib absent but one to three median longitudinal ridges or furrows often present in basal part. Leaf base truncated.

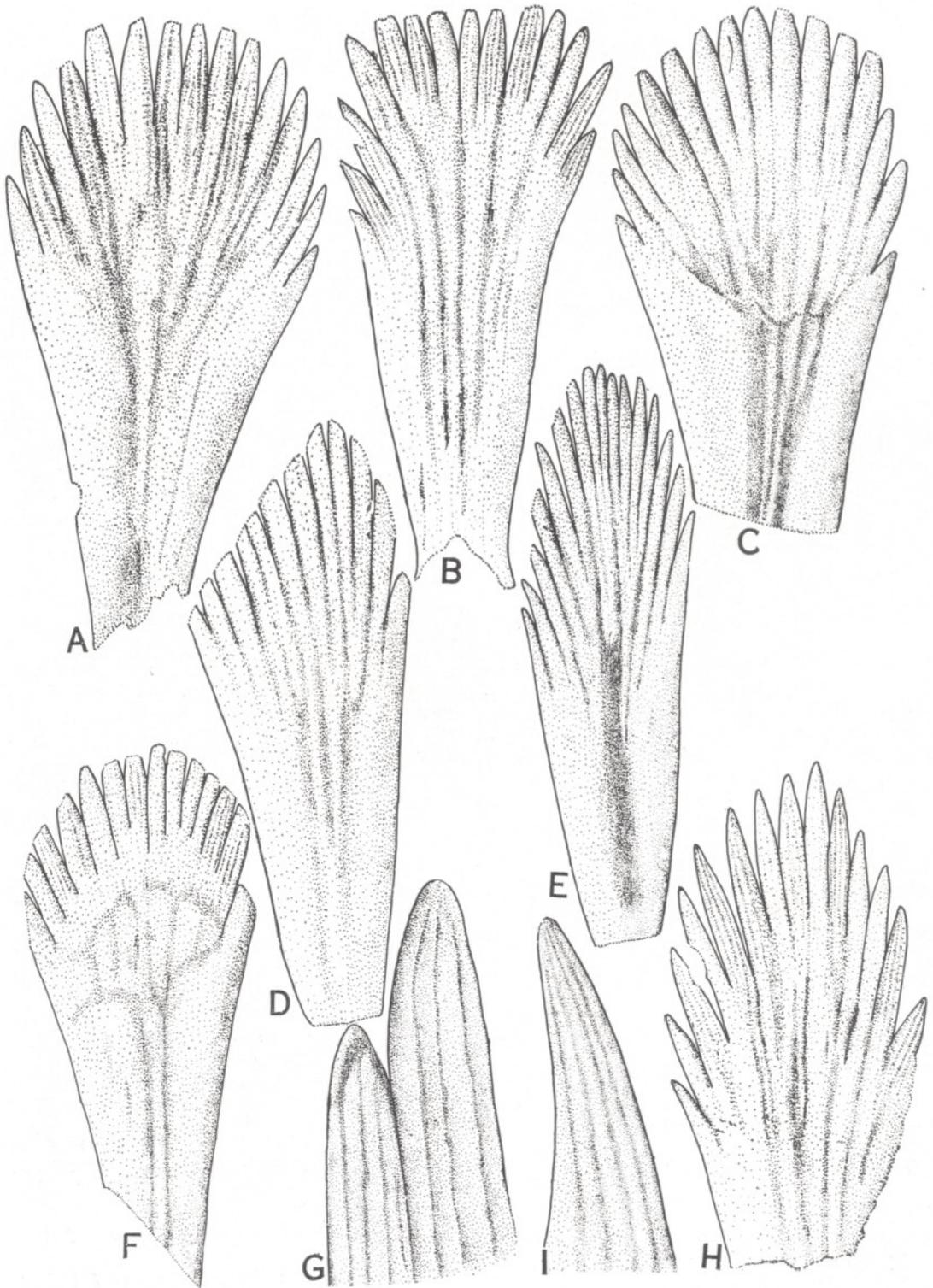
Leaf amphistomatic, stomata on one surface far more numerous than on other face. Stomata haplocheilic. Guard cells sunken.

Type Species — *Cheirophyllum lacerata* (Feistmantel) n. comb.

Cheirophyllum lacerata (Feistmantel) n. comb.

Pls. 1, 2; Text-figs. 1, 2

- 1886 *Noeggerathiopsis lacerata* Feistmantel, pl. 15, figs. 1-3, 4a; pl. 17, figs. 2, 3.
1902 *Noeggerathiopsis* (?) *lacerata* Zeiller, pl. 7, figs. 2, 3.
1905 (*Noeggerathiopsis* — ?) *lacerata* Arber, fig. 39.
1920 *Squama* forma *lacerata* Seward & Sahn, pl. 2, fig. 16.



TEXT-FIG. 1

1965 *Palmatophyllites lacerata* Maithy (Pars), text-fig. 11; pl. 2, figs. 16, 17, 18.

Diagnosis — Leaf small about 3 to 7 cm long, 1.5 to 3 cm wide in widest part, lamina tapering towards base, basal part 0.6 cm to 1 cm wide, middle portion of lamina showing one or a few ridges or grooves, apex of lamina showing 12 to 16 deeply cut lobes, lobes 1-2 cm long and 0.2-0.3 cm wide, sides parallel but pointed near distal end towards bluntly pointed apex, lobes showing 2-3 parallel veins.

Leaf amphistomatic but one surface paucistomatic and other multistomatic. Both cuticles thick, cuticle of paucistomatic surface thicker about 4 μm thick, cuticle of multistomatic surface about 3 μm thick.

Cells of paucistomatic surface not differentiated into vein and mesh areas, cells rectangular, longitudinally elongated, averaging at 78 μm \times 31 μm (68-93 μm long \times 22-33 μm wide), anticlinal walls of cells straight, 3 μm thick, surface of cells usually showing a single thickened papilla 12 μm wide.

Multistomatic surface showing differentiation of vein and mesh areas, surface papillae over cells sometimes obscure or absent, non-stomatiferous vein areas 4-8 cell wide, cells averaging 89 \times 26 μm (74-112 μm long \times 22-31 μm wide), rectanguloid, longitudinally elongated, anticlinal walls straight, 3 μm thick. Cells of stomatiferous areas tending to be isodiametric, about 40 μm wide or long (31-46 μm long \times 34-46 μm wide). Anticlinal walls straight or arched about 3 μm thick, cells along margins narrow and elongated.

Stomatiferous areas showing one to four ill-defined longitudinal rows of stomata, stomata of adjacent rows generally alternating with each other, stomata as a rule longitudinally orientated, haplocheilic, monocyclic or incompletely amphicyclic, subsidiary cells 4 to 8, forming a regular or irregular ring of short or elongated ordinary epidermal cells, inner (poral walls) of subsi-

diaries thickened, sometimes obscurely papillate overarching guard cells, polars not different from laterals, size of subsidiary cells averaging about 40 \times 33 μm , stomatal pit measuring 43 μm long \times 16 μm wide (37-46 μm long \times 15-19 μm wide). Surface of guard cells hyaline.

Lectotype — No. 5455; Museum, Geological Survey of India, Calcutta.

Locality — Dhamni, ca 2 miles south of Khaira, South Rewa Gondwana Basin.

Horizon — Karharbari Stage, Lower Gondwana.

Nomenclature — Under the name *Noeggerathiopsis lacerata* Feistmantel (1886) described clearly lobed detached leaves but their assignment to *Noeggerathiopsis*, which is a genus of unlobed spatulate leaves, is obviously improper. Zeiller (1902) suggested that leaves of this kind were similar to those of Ginkgoales but he even thought that they could be compared with *Whittleseya*, *Cycadospadix* and megasporophylls of *Cycas*. A comparison of *N. lacerata* with *Whittleseya* is untenable as it has been proved to be a microsporangiate organ of the pteridosperms (see Halle, 1929). The presumed similarity of *N. lacerata* with *Cycadospadix* or megasporophylls of *Cycas* is equally far-fetched since the leaves of *N. lacerata* are sterile. Another suggestion about the nature of the leaves of *N. lacerata* was made by Seward and Sahni (1920), who thought that they could be protective bracts of some cordaitan reproductive shoots and accordingly they named them *Squama* forma *lacerata*. The name *Squama* is, however, applied to imperfectly preserved scales of diverse form and affinities. Some of them have been assigned to *Glossopteris* (Walton, 1929) on account of their showing similar anastomosing veins while other unlobed scales have been thought to belong to *Noeggerathiopsis* (Seward & Sahni, 1920). We are, therefore, inclined to think that the present structurally preserved, clearly lobed leaves need to be assigned to a new genus even though, Maithy (1965) has

TEXT-FIG. 1 — *Cheirophyllum lacerata*: A — F, H, wide and narrow leaves. The bases of leaves in D, E appear to have been clearly abscissed. (A — F, H specimen nos. 8001 \times 2; 8003 \times 2; 8007 \times 2; 8005 \times 1.5; 8008 \times 1.5; 5535 \times 1.5; 8000 \times 2, respectively). G, I, lobes of leaves in F and H enlarged to show venation \times 12.



TEXT-FIG. 2

already included all previously described leaves of *Noeggerathiopsis lacerata* Feistmantel and also some of his own freshly found duplicate specimens to *Palmatophyllites lacerata* (Feistmantel) Maithy.

While Maithy retained Feistmantel's specific epithet "*lacerata*" in his new combination, contrary to rules he selected one of his own duplicate specimens as the holotype, and another as isotype, of the new combination. His generic diagnosis too, is defective since he wrongly described that the lobes were univeined and also mixed up therein the characters of a seed (Maithy, 1965, specimen no. 32805/499, Central Pit, pl. 2, figs. 19, 20; text-fig. 12) which is surrounded by a number of processes. One of us (D. D. P.) has examined both the specimens (Maithy's holotype, specimen nos. 31395/425 or 31393/425) and found that their lobes are multiveined. Further, it is now clear that his isotype, specimen no. 32805/499, is a cupulate seed which is quite different from his other specimens belonging to *N. lacerata*. Maithy has in fact made self contradictory statements when he calls specimen no. 31395/425 as holotype in the text and specimen no. 31393/425 as the holotype in the explanation of pl. 2, fig. 16. Moreover, the genus *Palmatophyllites* is invalid under Articles 7 and 63 of the "International Code of Botanical Nomenclature" which lays down that a new combination must be 'typified by the type of the basionym' (Article 7) and that "a name is illegitimate and is to be rejected if it was nomenclaturally superfluous when published, i.e. if the taxon to which it was applied as circumscribed by its author, included the type of a name or epithet which ought to have been adopted under the rules" (Article 63). Accordingly, the

leaves of this form are here included under a new name, *Cheirophyllum* gen. nov.

Description, Comparison & Discussion—In spite of the fact that the lectotype and other specimens of *Noeggerathiopsis lacerata* in Feistmantel's type collection, kept in the G.S.I. Museum, do not show any well-preserved carbon, the newly found structurally preserved duplicates described in this paper are referred to the same species since their size and external form are identical to those of the type material.

The diagnosis is based on a first hand study of Feistmantel's type material from South Rewah Gondwana basin (kept in the Museum of the Geological Survey of India, Calcutta), as well as Maithy's duplicate material from Srirampur Colliery, Giridih Coalfield (kept in Birbal Sahni Institute of Palaeobotany, Lucknow) and our own duplicates from Passerabhia in the same coalfield (kept in the Botany Department, Allahabad University). The diagnosis also takes into account the description and figures given by Feistmantel (1886) and Maithy (1965).

The external features of the numerous specimens described from different localities, all of Karharbari Stage, are identical. Indeed, fossil leaves of this kind are so far not reported from any other stage of Gondwanas. Accordingly, *Cheirophyllum* could be regarded as a reliable index fossil out of the numerous other fossils which are found in beds of this age, e.g. *Noeggerathiopsis*, *Gangamopteris*, *Glossopteris*, *Botrychiopsis*, *Phyllothea*, *Buriadia*, *Ottokaria*, *Cordai-carpus*, *Samaropsis*, *Rubidgea*, *Sphenopteris*, *Schizoneura*, *Arberia*, *Vertebraria* and *Euryphyllum*.

Out of sixteen leaves in our collection only nine are nearly complete and the

TEXT-FIG. 2 — *Cheirophyllum lacerata*: **A**, cuticle of paucistomatic surface showing papillate cells and one arrested stoma. Slide no. 5527a × 150. **B**, multistomatic cuticle showing stomatiferous and non-stomatiferous areas. Slide no. 5527a × 150. **C, D**, stomata from paucistomatic surface showing thinner partitions in subsidiary cells. Slide no. 5527a × 300. **E**, portion of **A** enlarged to show surface wall pittings. Slide no. 5527a × 500. **F, G**, abortive and arrested stomata from paucistomatic surface. Slide no. 5527a × 300. **H**, portion of **A** enlarged to show cells with papillae. Slide no. 5527a × 500. **I, K**, stomata from multistomatic surface magnified to show details. Slide no. 5527a × 300. The stoma in **I** shows an irregular ring of subsidiary cells. Stoma in **J** shows a regular ring but the regularity of subsidiaries in **K** is disturbed by an elongated polar; pits along anticlinal walls make them appear uneven.

counterpart of one of these complete specimens is also available. Wherever the leaf base is complete it is transversely truncated and seems to have been cut off by the formation of a clean abscission layer (Text-fig. 1 D, E; Pl. 1, fig. 5). In the remaining specimens the basal part is more or less broken. Seven specimens show clearly marked median ridges and another six show well-marked median grooves. This feature could, therefore, be due to one side of the leaf being grooved.

One of the two cuticles in the leaves (Pl. 2, fig. 12) is slightly thicker (4 μm) and paucistomatic (Text-fig. 2 A, C-H; Pl. 2, figs. 10, 11, 13) while the other is thinner (about 3 μm) and multistomatic (Text-fig. 2 B, I-K; Pl. 2, figs. 14-16). We, therefore, presume that the paucistomatic surface of the leaves was held upwards or kept more exposed by the plants.

The cuticles show clearly marked cell outlines. The anticlinal walls appear minutely dentate (Text-fig. 2 I-K) due to presence of pits and the surface of the cuticle shows a fine mottling caused by impressions of light coloured oval pits (Text-fig. 2E). Stomatal pores are clear but vague indications of the outlines of guard cells were also seen in some stomata. Otherwise the stomata show only the hyaline stomatal pit bounded by subsidiary cell walls. The irregular arrangement of subsidiary cells in some stomata and the occurrence of thinner partition walls in some stomatal subsidiaries may suggest that the cells which surrounded the guard cell mother cells were perigene and the regular rings of subsidiaries were perhaps formed by subsequent divisions in the perigene cells (Text-fig. 2 C, D; Pl. 2, fig. 11).

Between the ordinary epidermal cells on the paucistomatic surface are scattered a few dark or ordinary short cells, each of which is surrounded by a ring of cells which resembles the subsidiaries around a stoma (Text-fig. 2F, G; Pl. 2, fig. 10). The darker patches or short cells could, therefore, represent abortive or arrested stomata (see Pant, 1965), or hair bases although we could not find any hair over the leaves or the adjacent rock matrix.

A few disaccate *Striatites* type of pollen grains were found sticking to the paucistomatic cuticle of the leaves.

A comparison of *Cheirophyllum* with leaves of *Noeggerathiopsis* (to which they were previously assigned) and *Cordaites* shows that even though these leaves are clearly different from *Cheirophyllum* in being entire, their epidermal cells are arranged in similar stomatiferous and non-stomatiferous areas. All the same, the stomata in the leaves of *Noeggerathiopsis* and *Cordaites* have well-differentiated polar and lateral subsidiaries but in the stomata of *Cheirophyllum* the polars are not distinct from the laterals. A distinction of lesser importance pertains to the cells of the upper cuticle of *Noeggerathiopsis* and *Cordaites* being as a rule non-papillate whereas those of *Cheirophyllum* are typically papillate.

The multilobed character of *Cheirophyllum* leaves may be compared with that of some fossil Ginkgoales like *Sphenobaiera* (Harris & Millington, 1974), *Baiera* (Harris & Millington, 1974); and *Ginkgoites* (Seward, 1919), multifid leaves of a presumed conifer, *Buriadia* (Seward & Sahni, 1920; Pant & Nautiyal, 1967) and such unassigned genera of presumed coniferophytes like *Dichophyllum* (Elias, 1936; Andrews, 1941) *Dicranophyllum* (Grand'Eury, 1877) and *Trichopitys* (Saporta, 1875). However, the details of *Cheirophyllum* differ from those of all these leaves. Wherever known their epidermal structure too is different. The flattened leaf of *Cheirophyllum* has a clearly abscised undissected base which is almost as long as the apical lobed part. The leaf shows a dorsal and a ventral cuticle right up to the tips of the lobes. The lobes are multiveined, rather regular and almost equally incised and their tapering apices are bluntly pointed. In contrast, lobed leaves of *Ginkgo* and *Ginkgoites* differ from those of *Cheirophyllum* in having a distinct petiole and a wedge-shaped lamina which may show deeply incised flat blunt lobes. *Sphenobaiera* and *Baiera* too differ from *Cheirophyllum* in having irregularly dichotomised lamina often with unequal lobes. The flattened multifid leaves of *Buriadia* are narrower, cuneate and their univeined short segments may be equally or unequally incised. Attached leaves of *Dichophyllum* appear to arise from "axes" which could even be lower portions of much divided fronds which show more or less equal dichotomies ending in slender deeply cut

linear segments. The bases of the much narrower leaves of *Dicranophyllum* are decurrent and their apices show deeply divided lobes. The leaves of *Trichopitys* are described as being terete and as a rule they dichotomise repeatedly.

Cheirophyllum would thus appear to be an isolated kinless relic having no recognizable allies and since the other parts of the plant which bore these leaves are so far unknown, we are presently unable to determine even the broad group to which it belongs.

SUMMARY

Leaves described earlier as *Noeggerathiopsis lacerata* (Feistmantel, 1886) and some specimens called *Palmatophyllites* (Maithy, 1965) and a number of identical newly collected duplicates from the Lower Gondwana beds of Karharbəri Stage in the Giridih Coalfield are referred to *Cheirophyllum lacerata* (Feistmantel) n. comb. It is pointed out that

the lobed leaves of this kind cannot be referred to a genus of undivided spatulate leaves *Noeggerathiopsis* and that the name *Palmatophyllites lacerata* is illegitimate. The resistant cuticle of the newly collected duplicates is described and it suggests that these leaves may belong to the gymnosperms. However, a comparison of *Cheirophyllum* with other forms with similar looking leaves, e.g. *Sphenobaiera*, *Baiera*, *Ginkgoites*, *Buriadia*, *Dichophyllum*, *Dicranophyllum* and *Trichopitys* suggests that the genus is clearly different and at present unclassifiable.

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EXPLANATION OF PLATES

PLATE 1

Cheirophyllum lacerata

1-6. Wide and narrow leaves. The apical part of leaf in fig. 5 is complete and its base with a single median groove is truncated. Figs. 1 and 6 have two or more median grooves while figs. 2, 3, and 4 show median ridges. Figs. 1 to 6, respectively, specimen nos. 8007. \times 2; 8001. \times 2; 8003. \times 2; 8005. \times 1.5; 8008. \times 1.5; 5535. \times 1.5.

7. A few lobes of leaf in fig. 6 enlarged to show venation. \times 12.

PLATE 2

Cheirophyllum lacerata

8. Incident light photograph of a leaf. Specimen no. 8000. \times 2.

9. Same in oil. \times 2.

10. An abortive or arrested stoma from paucistomatic surface. Slide no. 5527a. \times 310.

11. An ordinary stoma from paucistomatic surface. Slide no. 5527a. \times 325.

12. Both cuticles from lobe apex. Slide no. 5527 a. \times 34.

13. Cuticle of paucistomatic surface showing papillae. Slide no. 5527a. \times 225.

14. Cuticle from multistomatic surface showing stomatiferous and non-stomatiferous bands. Slide no. 5527a. \times 130.

15, 16. Stomata from multistomatic surface showing number and arrangement of subsidiary cells. Slide no. 5527 a. \times 375.

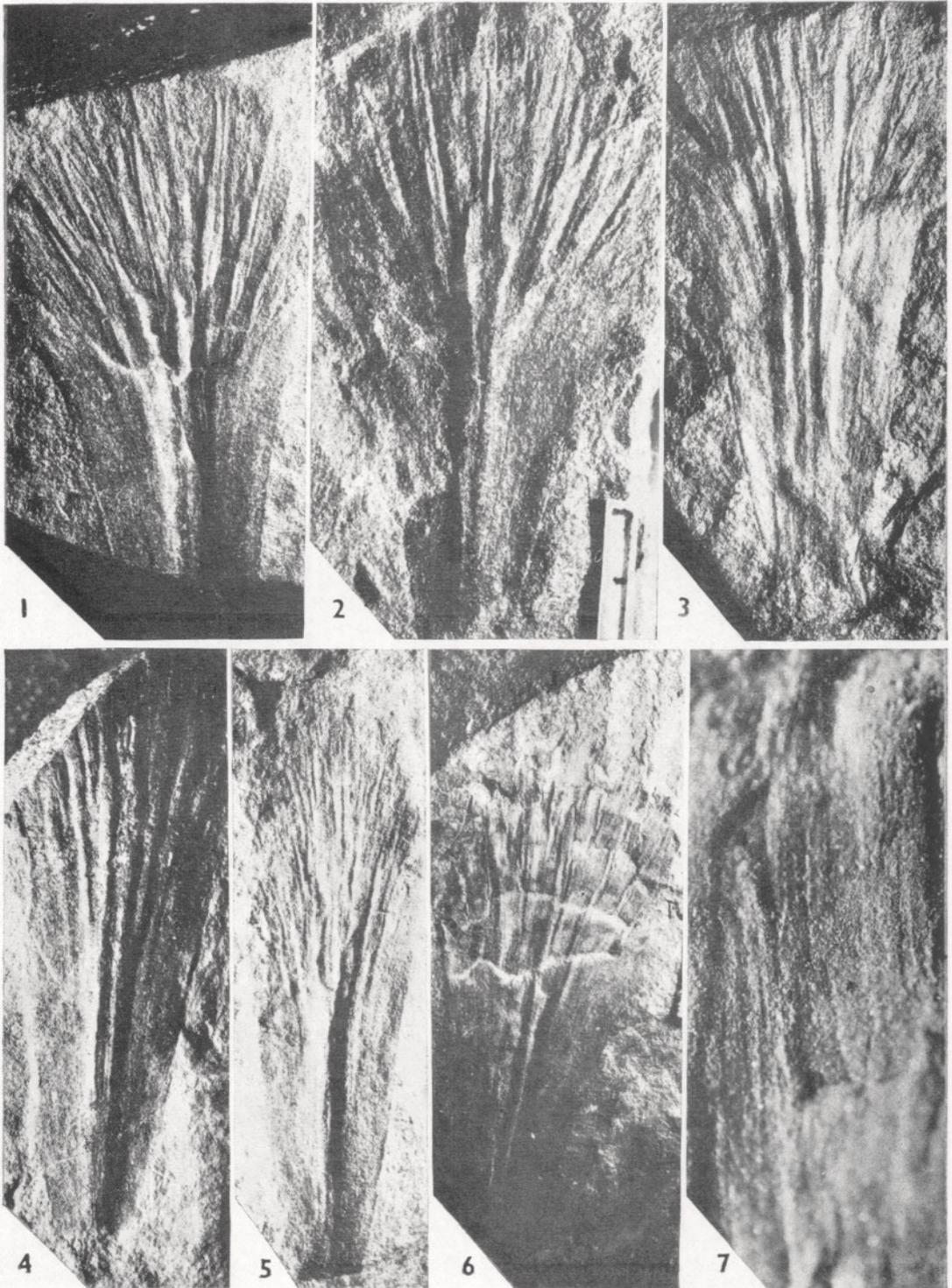


PLATE 1

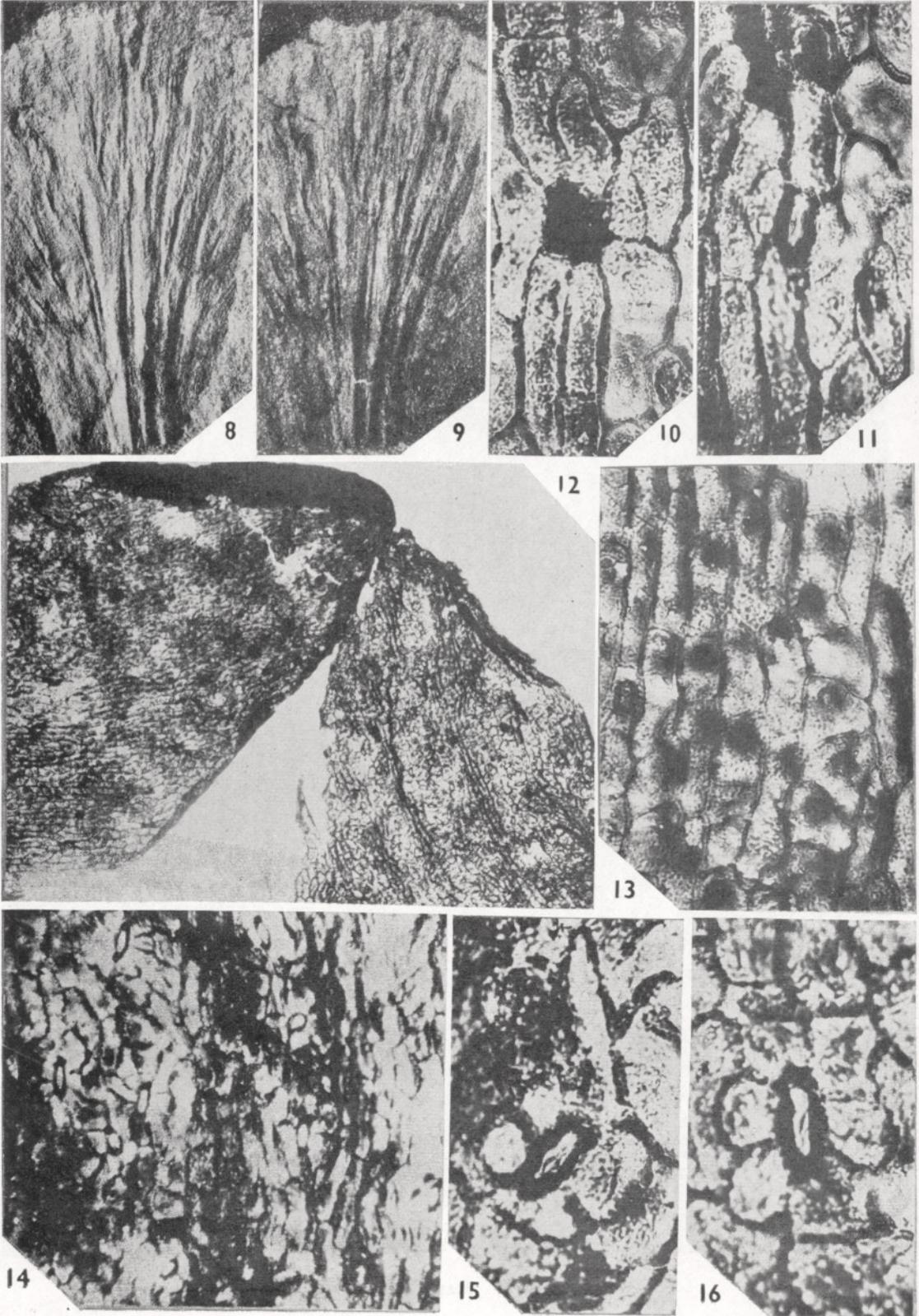


PLATE 2