

# THE GENUS *DICROIDIDIUM* FROM THE TRIASSIC OF NIDPUR, MADHYA PRADESH, INDIA

M. N. BOSE & SHYAM C. SRIVASTAVA

Birbal Sahnii Institute of Palaeobotany, Lucknow

## ABSTRACT

Three new species of *Dicroididium* are described here from the Triassic of Nidpur, Sidhi District, Madhya Pradesh. Externally these three species are very similar to each other except that in *D. nidpurensis* and *D. papillosum* the venation is odontopteroid type, whereas, in *D. gopadensis* it is alethopteroid type. In the cuticular structure these species differ from each other mainly in the presence or absence of papillae. In *D. nidpurensis* cell surface is smooth but in *D. papillosum* and *D. gopadensis* surface wall is usually papillate. In *D. papillosum*, subsidiary cells may be un-specialized or papillate, whereas, in *D. gopadensis* they are usually papillate.

## INTRODUCTION

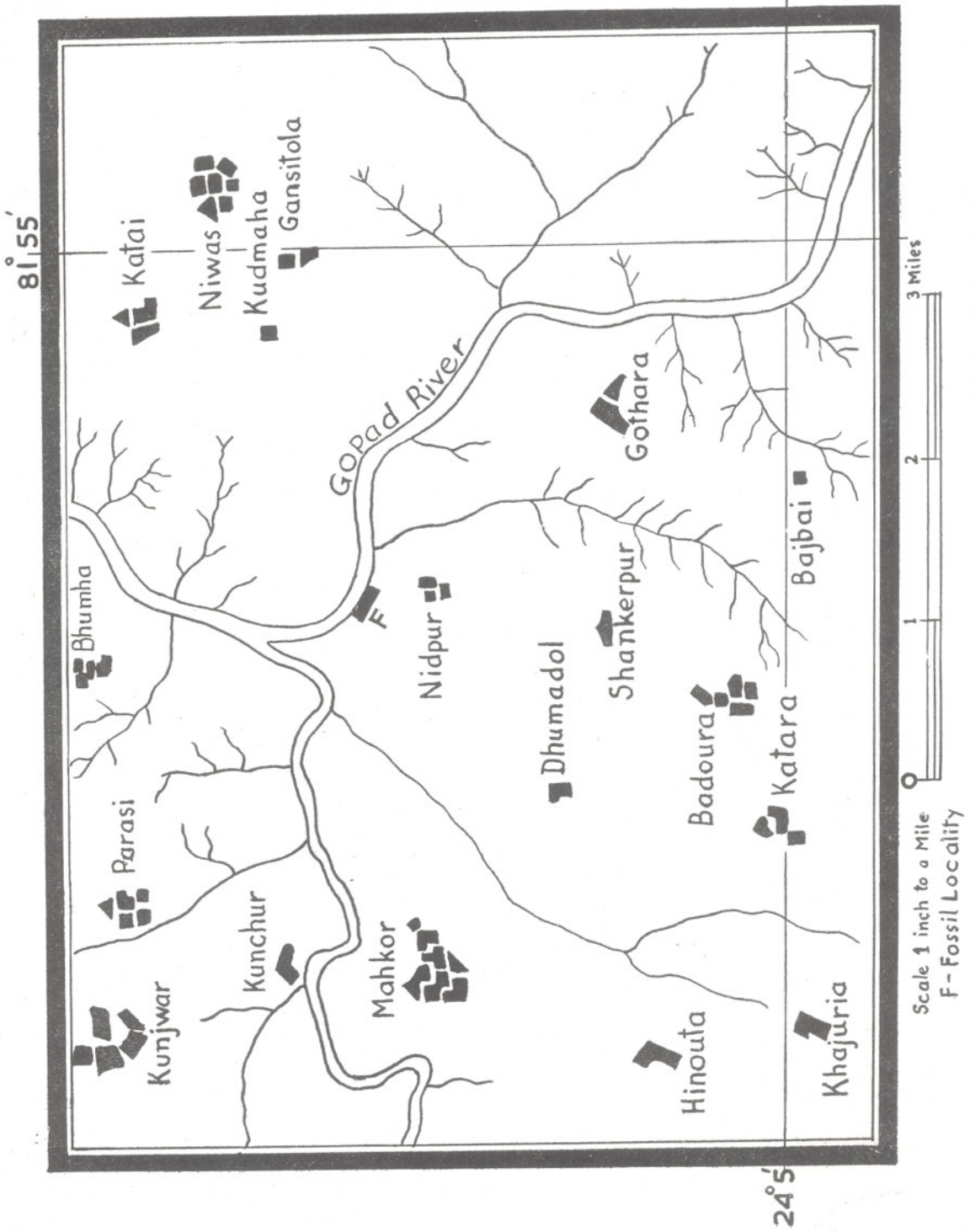
THE genus *Dicroididium* Gothan (1912) was redefined by Townrow (1957).

This genus shows a good deal of variation in general habit, venation and cuticular characters. The leaves of *Dicroididium* are mostly pinnate to bipinnate with forked rachis. But there are species which do not have forked rachis, viz. *D. feistmantelii* (Johnston) Gothan (rare specimens with forked rachis have also been reported, but their nature is doubtful). According to Townrow (1957), the venation in *Dicroididium* is often sphenopteroid, less often odontopteroid or alethopteroid. This character of venation is very variable because even within the same species different specimens show different types of venation. But in a few species, venation pattern is constantly the same, i.e. *D. hughesii* (Feistmantel) Townrow (see, TOWNROW, 1957, p. 37; LELE, 1961 has described this species in detail) where the venation is always alethopteroid type. The cuticle of *Dicroididium* varies from species to species in the nature of cell wall and stomatal apparatus. Normally cell surface is papillate in *Dicroididium* but species like *D. obtusifolium* (Johnston) Townrow (1966) and *D. walkomii* Jacob & Jacob (1950) have smooth walled cells. In *Dicroididium* subsidiary cells are often radially divided (TOWNROW, 1957, pp. 35, 41). The surface wall of the subsidiary cells is mottled or little specialized

but in some specimens they may be papillate as well.

From Nidpur (24°7' : 81°54'), Sidhi District, Madhya Pradesh more than one thousand specimens of *Dicroididium* have been collected (TEXT-FIG. 1). Out of them, three distinct species have been recognized. In none of the specimens, so far collected, forked rachis is present. The more complete ones only show the bipinnate nature. Venation in two of the species viz. *D. nidpurensis* and *D. papillosum* is odontopteroid type, whereas, in the third species, *D. gopadensis* it is alethopteroid type. The epidermal cells in *D. nidpurensis* have smooth surface-wall but in *D. papillosum* and *D. gopadensis* the cells are papillate. In *D. nidpurensis* the subsidiary cells are also devoid of papillae, in *D. papillosum* they may or may not be papillate and in *D. gopadensis* they are usually papillate. The number of subsidiary cells in all the three species is from 4-7, mostly they are 5 (in *D. nidpurensis* they may go even up to 8 but is rather rare). When the number is more than 4 or 5 it may be because of radial division of the lateral subsidiary cells. As there is no direct evidence of such division, here we have preferred to mention actual number of subsidiary cells visible as the final number (irrespective of any division implied).

According to Townrow (1957), the cuticle of *Dicroididium* is mostly delicate but there are species which have rather tough cuticle, viz. *D. superbum* (Shirley) Townrow (1957). Like *D. superbum* all the species of *Dicroididium* from Nidpur have tough cuticle. In this respect the Nidpur specimens resemble the genus *Høegia* Townrow (1957). But all the present species differ from *Høegia* in having dicyclic stomatal apparatus. In *Høegia* stomatal apparatus is usually monocyclic (TOWNROW, 1957 on page 47 has mentioned "encircling cells occasional" and on page 49 he has said that the stomata are usually monocyclic). But out of the two species described by him *Høegia papillata*



Scale 1 inch to a Mile  
F - Fossil Locality

TEXT-FIG. 1 — Map showing the fossiliferous locality near Nidpur, Sidhi District, Madhya Pradesh.

has very rarely encircling cells and *H. antevsiana* has encircling cells which are fairly frequent and subsidiary cells are never papillate. Among the Nidpur specimens, the subsidiary cells in *D. gopadensis* are usually papillate, whereas, in *D. papillosum* subsidiary cells are very rarely papillate and in *D. nidpurensis* they are never papillate. Townrow (1957) distinguishes *Høegia* from *Dicroidium* by its rachis cuticle. According to him the rachis stomata in *Høegia* are orientated parallel with long axes of epidermal cells, whereas, in *Dicroidium* they are orientated at right angle or obliquely to the long axis of the epidermal cells. In the specimens from Nidpur, the stomata are mostly longitudinally or slightly obliquely orientated. In this respect the Nidpur species come closer to *Høegia*. Again this particular character is not constant in *Dicroidium*, because in some specimens of *D. odontopteroides* and *D. obtusifolium* stomata in the rachis are more or less obliquely placed.

#### DESCRIPTION

##### *Dicroidium nidpurensis* sp. nov.

Pl. 1, Figs. 1-8; Pl. 2, Fig. 16; Text-figs. 2A-O, Text-figs. 3A-G

Bipinnate leaf of variable shape and size, measuring 1.2-13.7 cm. in length and 2.5-5 cm. in width. Main rachis measuring about 2-4 mm. in width, longitudinally finely striated or with transverse wrinkles or tiny lumps. Pinnae arising at an angle of about 40-55°, alternate. Pinnae rachis 1.4-2 mm. wide, surface showing transverse striations and wrinkles. Pinnules of variable shape and size, 0.4-2.3 × 0.4-0.6, cm., on lower side basal most pinnule near point of attachment oval or circular, higher up usually lanceolate or ovate, rarely oval; even in same pinnae some of the pinnules on one side much larger than the other side. Pinnules closely set, rarely distantly placed, arising at an angle of 40-70°. Margin entire or at places wavy or rarely slightly notched; acroscopic margin rounded or truncated, basicopic margin decurrent. Veins mostly odontopteroid type, in larger pinnules tending to form a midrib, laterals arising at a narrow angle, forked or un-forked, when forked mostly once.

Rachis cuticle on both surfaces thick. Cells arranged in longitudinal direction,

rectangular to polygonal, lateral-walls straight and end-walls oblique, surface-wall smooth. Stomata few, orientated along longer axes of cells, guard cells thin, cutinized all round, subsidiary cells irregular, 5-6 in number. Aperture thin, slit-like.

Cuticle of lamina on both surfaces more or less of same thickness, tough and amphistomatic. Upper cuticle showing irregularly scattered stomata on entire surface, vein cells not clearly recognizable. Cells polygonal or elongated rectangular; lateral- and end-walls mostly broken by pits or sinuous, sometimes straight; surface-wall unspecialised, sometimes a few cells slightly more cutinised, rarely a few cells with rudimentary papillae near base or margin. Stomata sparsely distributed, mostly longitudinally orientated, a few oblique or transverse. Subsidiary cells 4-8 in number but usually 5; lateral- and end-walls like ordinary cells, inner wall of subsidiary cells more cutinised; surface unspecialised. Stomatal pit rectangular, rhomboidal or slit-like. Guard cells sunken, wall cutinised. Encircling cells unspecialised. Lower cuticle showing non-stomatiferous and stomatiferous zones, a few stomata often occurring along veins as well. Cells of non-stomatiferous zones 2-4 cells wide, rectangular or polygonal, mostly much longer than broad. Nature of cell wall same as on upper side. Stomatal bands 4-8 cells wide; stomata irregularly distributed, mostly longitudinally orientated, a few obliquely placed, rarely transverse, amphicyclic. Stomatal apparatus similar to those on upper side.

*Holotype* — No. 33926.

*Locality* — Nidpur, Sidhi District, M.P., India.

*Age* — Lower Triassic.

#### COMPARISON

*D. nidpurensis* is a bipinnate leaf and as such, in general habit it resembles more the leaves of *D. feistmantelii* (Johnston) Gothan (1912) redescribed by Townrow (1957), and *D. sp. cf. D. talbragarensis* Walkom described by Jacob & Jacob in 1950 (the affinity of this specimen is doubtful, because the original specimens of *D. talbragarensis* Walkom has now been transferred under the genus *Pachypteris*, viz. *P. crassa* (Halle) Townrow, 1965). *D. nidpurensis* also resembles, in general habit, some of the

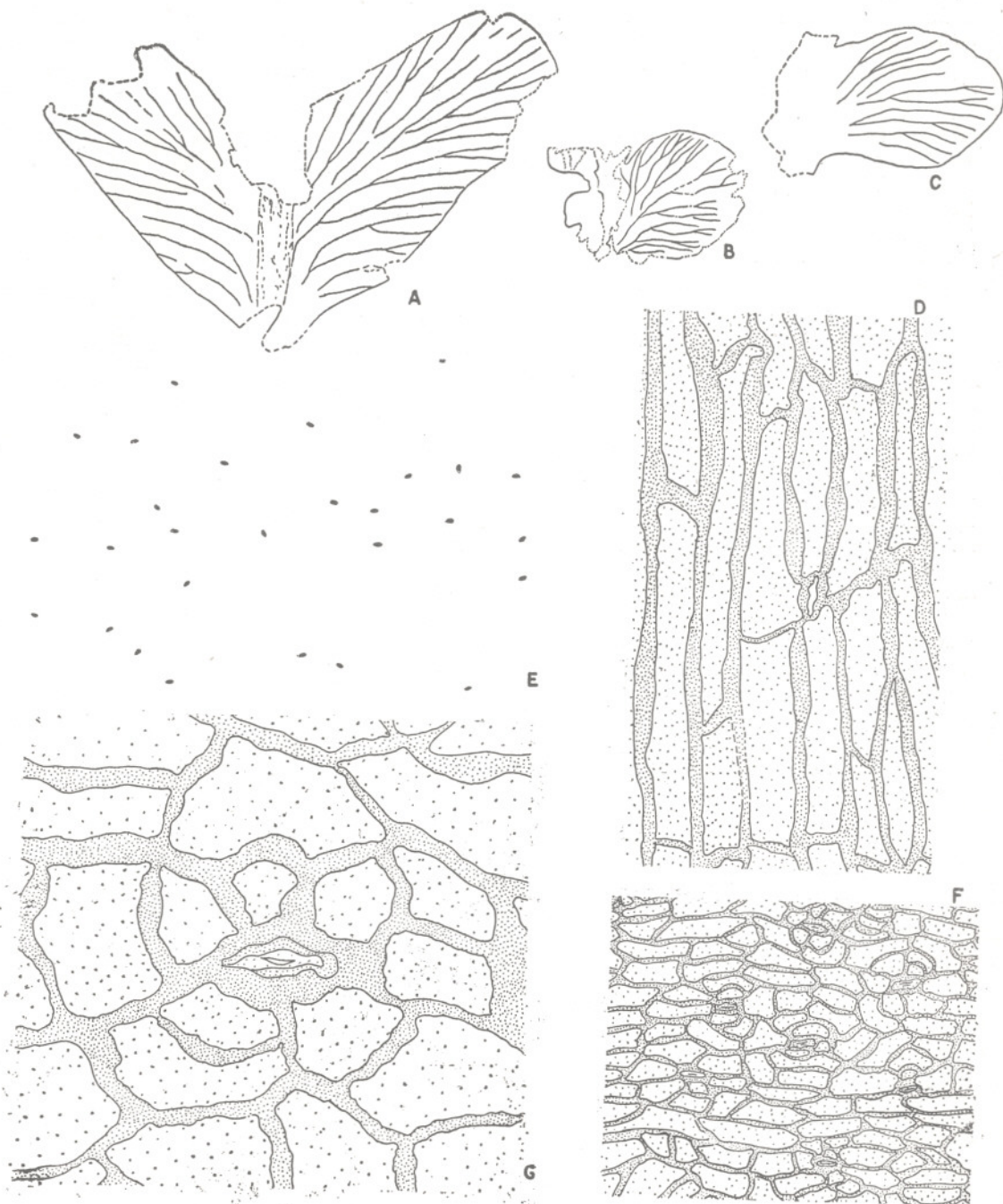


TEXT-FIG. 2—*Dicroidium nidpurensis* sp. nov.—A, specimen no. 33994.  $\times 1$ . B, specimen no. 33985.  $\times 1$ . C, specimen no. 33928.  $\times 1$ . D, specimen no. 33942.  $\times 1$ . E, specimen no. 34000.  $\times 1$ . F, specimen no. 33995.  $\times 1$ . G, specimen no. 33930.  $\times 1$ . H, specimen no. 33932.  $\times 1$ . I, specimen no. 34002.  $\times 1$ . J, specimen no. 33996.  $\times 1$ . K, specimen no. 34001.  $\times 1$ . L, specimen no. 33993.  $\times 1$ . M, specimen no. 33997.  $\times 1$ . N, specimen no. 33999.  $\times 1$ . O, specimen no. 33932.  $\times 1$ .

specimens of *D. odontopteroides* (Morris) Gothan (1912) which are bipinnate viz. the specimens reported by Gordon & Brown (1952, PL. 1, FIG. 5) and redescribed by Townrow (1957) from Brazil and the specimen by Lele (1955, p. 26, TEXT-FIG. 2) from Parsora Stage of India. But most of the specimens of *D. odontopteroides* differ from the present specimens in having forked rachis. Similarly, *D. narrabeenensis* Walkom (1925) described by Jacob & Jacob (1950), *D. walkomii* Jacob & Jacob (1950), *D. superbum* (Shirley) Townrow (1957), *D. sp. cf. D. feistmantelii* (Johnston) Gothan (1912) and *D. hughesii* (Feistmantel) Townrow (1957) described by Lele (1961), *D. sahnii* (Seward) Rao & Lele (1962), *D. obtusifolium*

(Johnston) Townrow (1966) differ from *D. nidpurensis* in having forked rachis. *D. coriacium* (Johnston) Townrow (1957) can be readily distinguished from *D. nidpurensis* by its forked rachis and pinnatifid lamina.

In cuticular characters, *D. nidpurensis* can be distinguished from *D. feistmantelii* by its thick cuticle, non-papillate epidermal cells and subsidiary cells which are usually 5 but ranging 4-8 in number. In *D. feistmantelii* cuticle is very thin, epidermal cells are usually papillate and subsidiary cells are few in number mostly, 4 or 5. The cuticle of *D. sp. cf. D. talbragarensis* (Walkom) described by Jacob & Jacob (1950) differs from the present species in having cells with striated surface-wall and also in having



TEXT-FIG. 3 — *Dicroidium nidpurensis* sp. nov.— A, specimen magnified to show venation; slide no. 33943.  $\times 3$ . B, showing venation; slide no. 33944.  $\times 3$ . C, showing venation; slide no. 33938.  $\times 3$ . D, Rachis cuticle, showing epidermal cells and a stoma; slide no. 33946-1.  $\times 250$ . E, Lower surface, showing distribution of stomata; slide no. 33946-2.  $\times 40$ . F, Lower surface, showing a few stomata and epidermal cells; slide no. 33945-1.  $\times 100$ . G, a single stoma; slide no. 33945-1.  $\times 500$ .

subsidiary cells which are 2-4 in number. Unlike the cuticle of *D. nidpurensis*, the cuticle of *D. odontopteroides*, as described by Townrow (1957), has papillate cells on both surfaces and subsidiary cells are fewer in number, i.e. 4-5. Also the cuticle of *D. odontopteroides* is thinner than the present species. Epidermal cells of *D. narrabeneensis* Walkom (1925), as described by Jacob & Jacob (1950), is striated or papillate and in this species subsidiary cells are 2-4 in number. *D. walkomii* Jacob & Jacob (1950) has striated cells but like *D. nidpurensis*, cells are non-papillate and subsidiary cells are 2-4 in number. Cuticle of *D. superbum* is tough, cells bear small and indistinct papillae. In *D. sp. cf. D. feistmantelii* stomata on one surface are more in number than the other surface, subsidiary cells are 4 in number.

Besides the rachis character *D. hughesii* can be distinguished from *D. nidpurensis* by the nature of its venation because in *D. hughesii* venation is of alethopteroid type. Also in *D. hughesii* some of the cells are papillate and stomata are more on one surface. *D. sahnii* (Seward) Rao & Lele (1962) is distinguished from the present species by the presence of papillate cells and also in having fewer number of subsidiary cells. *D. nidpurensis* comes closer to *D. obtusifolium* (Johnston) Townrow (1966) in having mostly smooth walled cells, but the latter species differs from the former in having only 4 subsidiary cells but usually one or both lateral subsidiary cells are divided radially. *D. coriacium* (Johnston) Townrow (1957) is very distinct from *D. nidpurensis* because in the former lamina is pinnatifid and its cuticle is thin. Also cells are papillate and subsidiary cells are 4-5 in number.

*Dicroidium papillosum* sp. nov.

Pl. 2, Figs. 9-15; Pl. 3, Figs. 17-22; Text-figs. 4F-H; Text-figs. 5A-C.

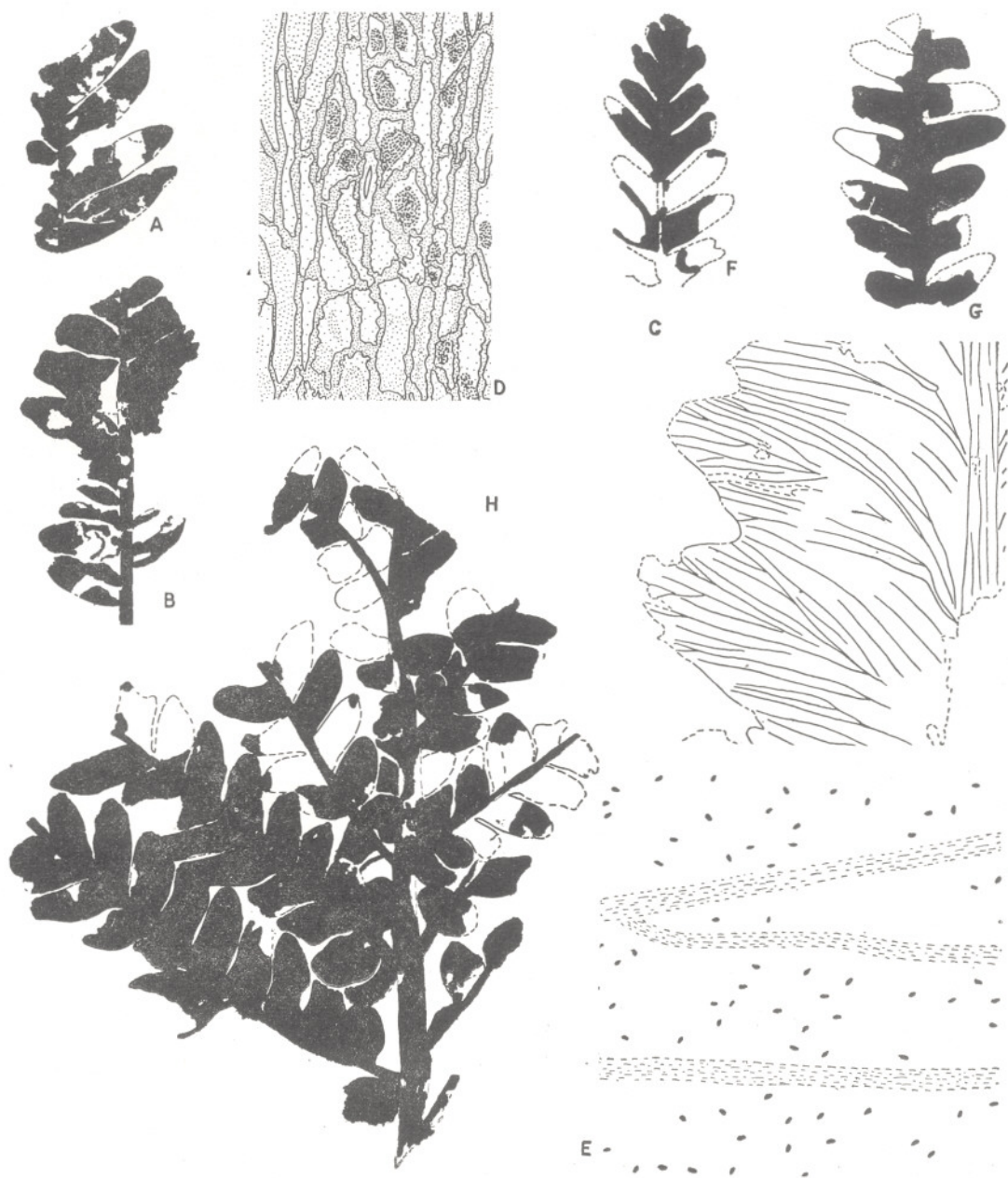
Fronn bipinnate, largest specimen measuring 12 cm. in length and 9.9 cm. in breadth (range noted 4.6-12 cm.  $\times$  2.9-9.9 cm.). Rachis fairly thick, showing minute lumps and irregular wrinklins, sometimes finely striated, 2-6 mm. wide. Pinnae alternate or sub-opposite, arising at an angle of about 40-60°, near apex making an angle of about 40°; pinnae measuring

3-7 cm. in length, 2-3 cm. in breadth. Pinnae rachis finely striated or at times with tiny lumps. Pinnules arising at an angle of about 50-70°, inserted laterally but somewhat closer to upper surface of rachis, broadly oval to lanceolate, lower most pinnule on lower side, more or less rhomboidal in shape, with obtuse to rounded apex, pinnule nearest to main rachis on upper side more or less semi-circular to circular in shape. Margin entire or near base slightly notched, acroscopic margin constricted, basisopic margin slightly decurrent. Veins finely marked, odontopteroid type.

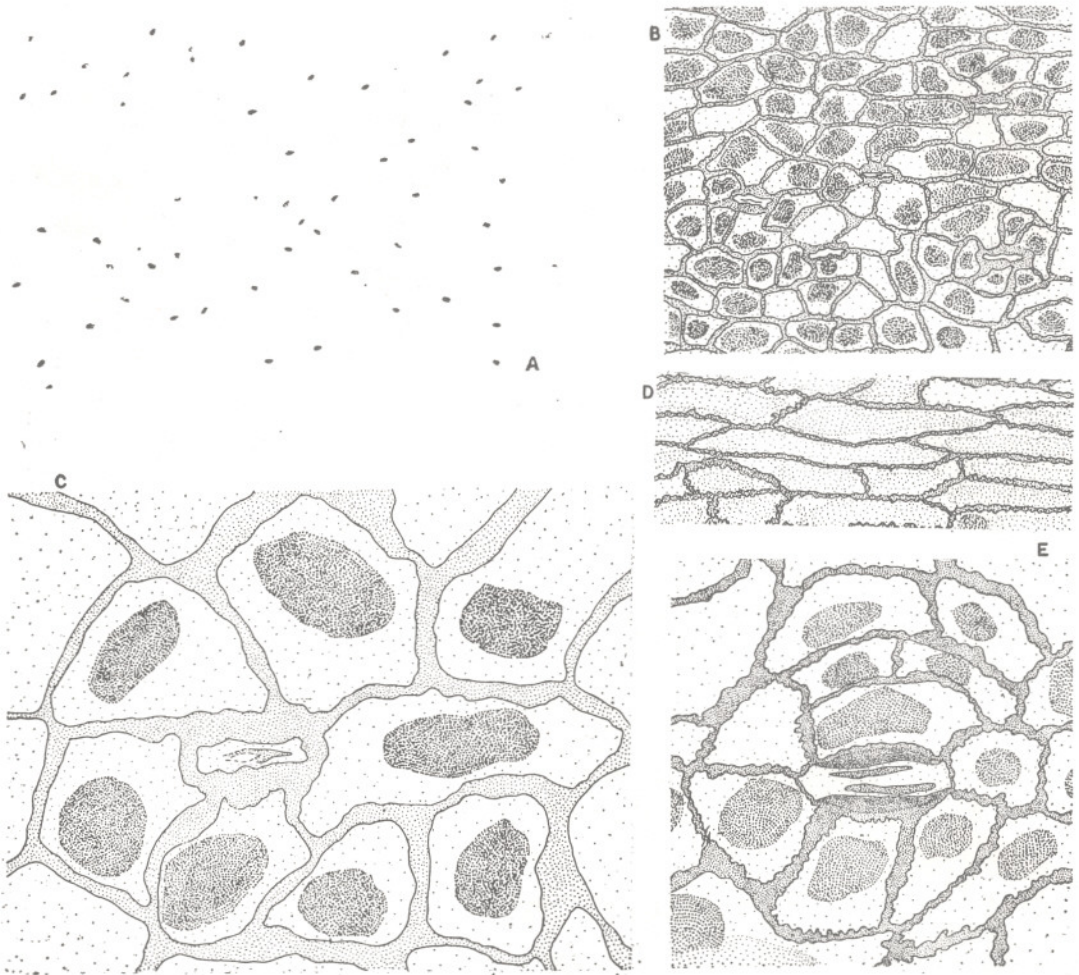
Cuticle of main rachis thick, both surfaces similar in structure. Epidermal cells elongated and arranged in longitudinal direction, rectangular to rhomboidal; lateral-walls straight and end-walls oblique, rarely straight. Surface-wall generally smooth, sometimes thickened but without any definite papillae. Stomata sparsely distributed. Guard cells weakly cutinized, subsidiary cells 4-5 in number. Aperture slit-like.

Pinna rachis cuticle similar to that of main rachis, only ordinary epidermal cells slightly smaller in size and not so thickened.

Cuticle of lamina on both surfaces more or less of similar thickness, about 6  $\mu$  thick. Upper surface not showing clearly marked vein cells (no distinct stomatal and non-stomatal zones). Cells mostly polygonal, a few rectangular or isodiametric, whenever cells along veins recognizable mostly polygonal; lateral- and end-walls straight, broken by pits or sinuous; surface-wall mostly with a solid circular or oval papillae, sometimes a few cells merely thickened. Stomatal apparatus amphicyclic or incompletely amphicyclic, subsidiary cells 4-7, mostly 5 in number, surface-wall papillate or non-papillate. Stomatal pit dumble-shaped. Guard cells cutinized, sunken. Encircling cells like ordinary epidermal cells. Lower surface showing distinct stomatal and non-stomatal zones occasionally a few stomata occurring along vein cells as well. Cell along veins more or less rectangular or polygonal, serially arranged; lateral- and end-walls sinuous, pitted or straight; surface-wall thickened or with a solid papillae. Cells within stomatal zone without any definite arrangement, polygonal, lateral- and end-walls mostly sinuous, surface merely thickened or papillate. Stomata



TEXT-FIG. 4—*Dicroidium gopadensis* sp. nov.—A, specimen no. 33958.  $\times 1$ . B, specimen no. 33961.  $\times 1$ . C, showing venation; no. 33960.  $\times 5$ . D, rachis cuticle, showing stomata and epidermal cells; slide no. 33962-3.  $\times 250$ . E, showing distribution of stomata; slide no. 33962-1.  $\times 40$ . *Dicroidium papillosum* sp. nov.—F, specimen no. 33957.  $\times 1$ . G, specimen no. 34006.  $\times 1$ . H, Holotype specimen no. 33952.  $\times 1$ .



TEXT-FIG. 5 — *Dicroidium papillosum* sp. nov.— A, showing distribution of stomata; slide no. 33957-1.  $\times 40$ . B, Lower surface, showing a few stomata and epidermal cells; slide no. 33952-1.  $\times 250$ . C, a single stoma; slide no. 33952-1.  $\times 500$ . *Dicroidium gopadensis* sp. nov.— D, epidermal cells from the non-stomatiferous region, i.e. vein region; slide no. 33962-1.  $\times 250$ . E, a single stoma; slide no. 33962-1.  $\times 500$ .

irregularly distributed, mostly longitudinally orientated, a few obliquely or transversely placed, sparse, never sharing a common subsidiary cell. Subsidiary cells 4-7, usually 5; lateral- and end-walls like ordinary epidermal cells; surface-wall with or without papillae. Encircling cells like ordinary cells. Nature of pit and guard cells similar to upper side.

*Holotype* — No. 33952.

*Locality* — Nidpur, Sidhi District, M.P., India.

*Age* — Lower Triassic.

*Remarks* — *D. papillosum* shows a good deal of variation regarding the presence of papillae. In most of the specimens small, circular and solid papillae are present on both the surfaces. In some specimens all the cells may be papillate, whereas, in others a few cells may be devoid of papillae. In a few specimens cells on the lower surface may be papillate while the cells on the upper surface may have only thickened or mottled surface-wall.



## COMPARISON

In gross features *D. papillosum* resembles most *D. nidpurensis*, it, however, differs from the latter species in having papillate cells. In being bipinnate and in general shape of pinnules *D. papillosum* also resembles *D. feistmantelii* (Johnston) Gothan (1912). But the former species can readily be distinguished from the latter by its thick cuticle and number of subsidiary cells which are 4-7 in number. In *D. feistmantelii*, cuticle is rather delicate, being about 1  $\mu$  thick and subsidiary cells are 4-5 in number. The present specimens resemble *D. odontopteroides* in having papillae on both the surfaces but the latter species is quite distinct from the former because its cuticle is thin and also it has a lesser number of subsidiary cells i.e. 4-5. Besides these species, *D. papillosum* also resembles to some extent *D. narrabeenensis* Walkom (1925) described by Jacob & Jacob (1950), *D. superbum* (Shirley) Townrow (1957), *D. coriacium* (Johnston) Townrow (1957), *D. hughesii* (Feistmantel) Townrow (1957) described by Lele (1961) and *D. sahnii* (Seward) Rao & Lele (1962) in having papillate cells. But in all the latter mentioned species papillae are rather rare. Otherwise *D. papillosum* differs from all the species in the same way as *D. nidpurensis*.

*D. papillosum* also resembles *Høegia papillata* Townrow (1957) in having papillate epidermal cells but the latter species differs from the former in having non-papillate subsidiary cells. Also in *H. papillata*, unlike *D. papillosum* the cells of rachis are usually papillate.

*Dicroidium gopadensis* sp. nov.

Pl. 3, Figs. 23; Pl. 4, 24-30; Text-figs. 4A-E; Text-figs. 5D-E.

Detached pinnae, measuring 3.5-6.1 cm. in length and 2.3-4.7 cm. in breadth. Rachis about 2-3 mm. wide, finely striated in longitudinal direction. Pinnules 1.9-2.7 cm. long and 0.9 cm. broad, arising at an angle of about 40 to 70°, typically 45°; ovate to broadly lanceolate, closely set, almost touching each other, towards apex lamina not forming distinct pinnule, only notched (pinatifid). Pinnule margin entire, rarely slightly wavy at places, in some near apex somewhat dentate; apex rounded or obtuse;

acroscopic margin contracted, basisopic margin decurrent. Veins distinct, one principal vein arising from rachis, forming a midrib, also in some near base a few smaller lateral veins arising directly from rachis. Midrib giving secondaries at narrow angles, secondary veins forked or unforked, when dividing once or twice. Near apex when lamina not forming distinct pinnules, quite a few veins arising directly from rachis without forming distinct midrib.

Rachis cuticle on both surfaces similar, about 2.5  $\mu$  thick. Cells rectangular or rhomboidal in shape, lateral-walls straight and end-walls oblique; surface-wall mostly smooth, sometimes slightly thickened. Stomata longitudinally orientated, subsidiary cells mostly 5, cell wall slightly wavy at places, surface smooth or thickened Guard cells sunken. Aperture slit-like.

Lamina cuticle similar on both surfaces, about 2.5  $\mu$  thick, amphistomatic. Both surfaces showing distinct stomatal and non-stomatal bands. Non-stomatal bands 3-4 cells wide, cells rectangular or with pointed ends, serially arranged; lateral- and end-walls undulated; surface-wall mostly thickened, sometimes with a circular or oval solid papillae lying mostly close to one end. Stomatal bands 2-4 stomata wide but usually 3-4 stomata wide, stomata generally irregularly scattered, longitudinally, obliquely or transversely orientated; mostly longitudinally or obliquely placed, very rarely transverse. Subsidiary cells 4-7 in number, mostly 5; cell wall wavy or slightly undulated, surface papillate or non-papillate; when papillate, papillae mostly solid. Guard cells sunken, finely striated in transverse direction. Encircling cells having distinct papillae or sometimes only slightly thickened. Ordinary epidermal cells polygonal, irregularly packed; lateral- and end-walls sinuous or undulated; surface-wall mostly papillate. Papillae circular or oval, solid, very rarely hollow.

*Holotype* — No. 33962.

*Locality* — Nidpur, Sidhi District, M.P., India.

*Age* — Lower Triassic.

*Remarks* — The general habit of *Dicroidium gopadensis* is not known because all the specimens, so far, collected are detached fragments. For description *D. gopadensis* has been assumed to be bipinnate. None of the specimens at hand show the usual forked rachis like *D. odontopteroides*.

## COMPARISON

Because of the fragmentary nature of *Dicroidium gopadensis* it is not possible to compare the general habit of this species with those of the other species of *Dicroidium*. However, in the nature of venation the pinnules of *D. gopadensis* resemble most *D. hughesii* (Feistmantel) Townrow (1957). Because in both, pinnules have distinct midrib. *D. hughesii* can readily be distinguished from *D. gopadensis* by the size of their pinnules alone. In *D. hughesii*, pinnules are much larger than *D. gopadensis*. Cuticle of *D. gopadensis* is quite distinct from *D. hughesii* as described by Lele (1961). In *D. gopadensis* both the surfaces are similar, it has distinct stomatal and non-stomatal bands, its cell surface is mostly papillate or

thickened and it has 4-7 subsidiary cells (mostly 5). Whereas, in *D. hughesii* stomata are more on one surface than on the other (see Lele, 1961, p. 57), stomatal and non-stomatal zones are not so distinct, cells are not always papillate and also the lateral- and end-walls in the former species are undulated, whereas, in *D. nidpurensis* cell wall is rarely undulated and the cell surface is not papillate. *D. gopadensis* differs from *D. papillosum* in having pinnules with distinct midrib. Its cuticle differs from the latter species in having cells with sinuous lateral- and end-walls and its both upper and lower cuticles have distinct stomatiferous and non-stomatiferous zones. In *D. papillosum* cell wall is straight and the stomatiferous and non-stomatiferous zones are not so distinct.

## REFERENCES

- GORDON, M. & BROWN, R. W. (1952). Plantas Triassicas do sul do Brasil (1). *Notas prelim. Estud. Div. Geol. Miner. Bras.* 54: 1-6.
- JACOB, K. & JACOB, C. (1950). A preliminary account of the structure of cuticle of *Dicroidium* (*Thinnfeldia*) fronds from the Mesozoic of Australia. *Proc. natn. Inst. Sci. India*, 16(2): 101-126.
- LELE, K. M. (1955). Plant fossils from Parsora in the South Rewa Gondwana Basin. *Palaebotanist*, 4: 33-34.
- Idem (1961). Studies in the Indian Middle Gondwana flora-1. On *Dicroidium* from the South Rewa Gondwana Basin. *Ibid.* 10(1): 48-68.
- RAO, A. R. & LELE, K. M. (1962). On the cuticle of *Dicroidium* (*Thinnfeldia*) *sahnii* (Seward) with some observations on the genera *Thinnfeldia* and *Dicroidium*. *Palaebotanist*, 11(1,2): 7-12.
- TOWNROW, J. A. (1957). On *Dicroidium*, probably a pteridospermous leaf and other leaves now removed from this genus. *Trans. geol. Soc. S. Afr.* 60: 21-56.
- Idem (1965). A new member of Crystospermaceae Thomas. *Ann. Bot.* 29 (115): 495-511.
- Idem (1966). On *Dicroidium odontopteroides* and *D. obtusifolium* in Tasmania. *Symposium Floristics Stratigraphy Gondwanaland. Palaeobotanical Society Spl. Sess. Dec.* 1964: 126-136.
- WALKOM, A. B. (1925). Fossil plants from the Narrabeen Stage of Hawkesbury Series. *Proc. Linn. Soc. N.S.W.* 50(3): 214-224.

## EXPLANATION OF PLATES

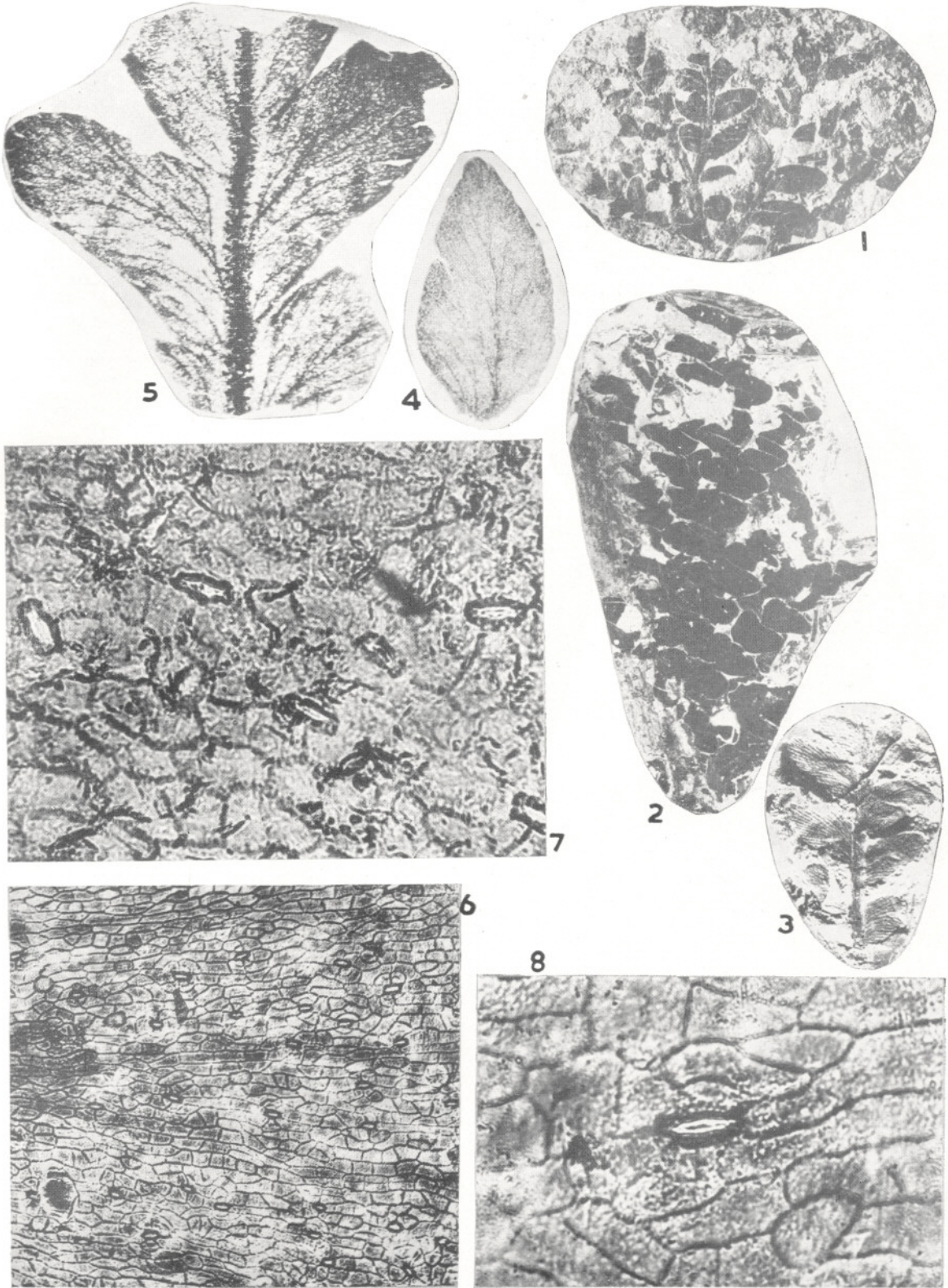
## PLATE 1

*Dicroidium nidpurensis* sp. nov.

- 1-3. Holotype No. 33926 (Fig. 1), nos. 33946 (Fig. 2) and 33940 (Fig. 3).  $\times 1$ .
- 4-5. A few pinnules showing venation; Slide No. 33941 (Fig. 4).  $\times 3$ . Slide No. 33939 (Fig. 5).  $\times 4$ .
6. Lower surface, showing distribution of stomata; Slide No. 33945-1.  $\times 40$ .
7. Lower surface, showing epidermal cells with pitted and undulated cell walls and a few stomata; Slide No. 33926-1.  $\times 150$ .
8. Lower surface, showing a stoma; Slide No. 33945-1.  $\times 250$ .

## PLATE 2

- 9-13. *Dicroidium papillosum* sp. nov., holotype No. 33952 (Fig. 9), Nos. 33947 (Fig. 10), 33951 (Fig. 11), 33949 (Fig. 12) and 34006 (Fig. 13, counter part of specimen figured in Text-fig. 3G).
- 14-15. *D. papillosum* sp. nov., two specimens showing nature of venation; Slide Nos. 33956-1.  $\times 4$  and 33954.  $\times 2$ .
16. *Dicroidium nidpurensis* sp. nov., cuticle, showing epidermal cells and a few stomata; Slide No. 33946-1.  $\times 150$ .



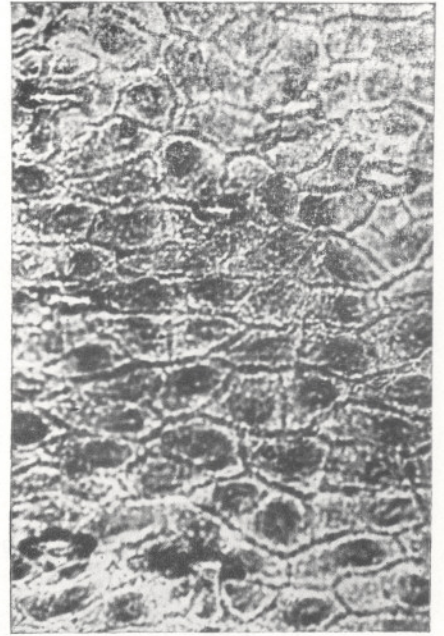




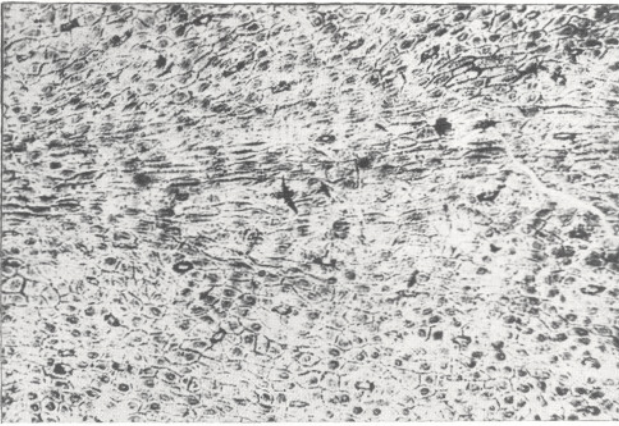
17



18



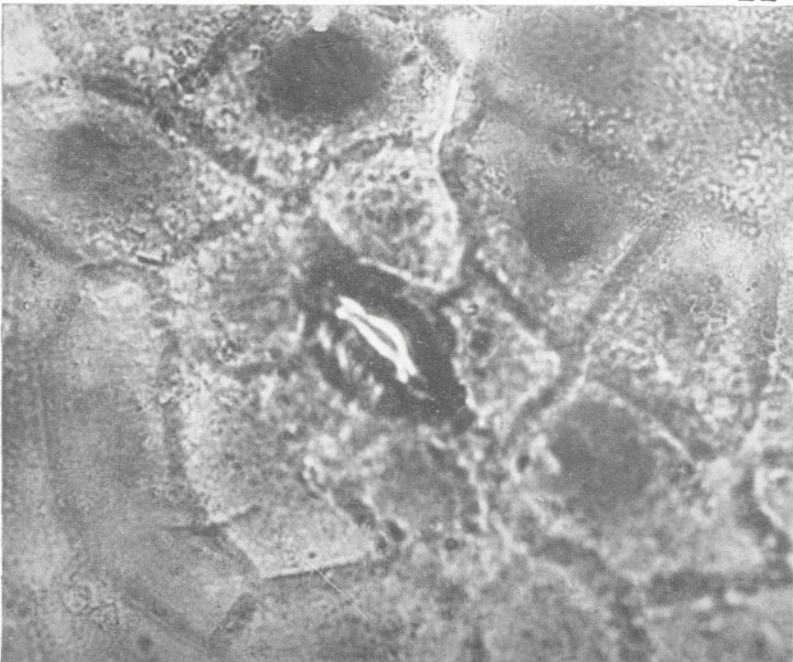
21



20



19



22



23



26



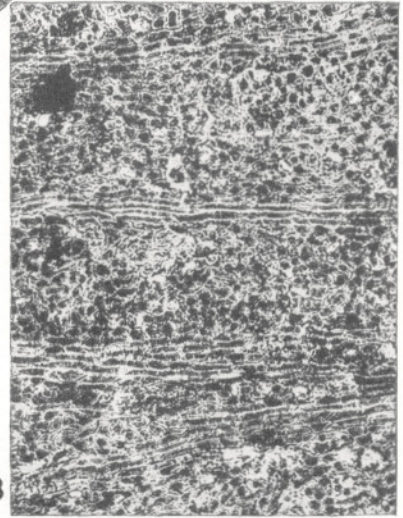
24



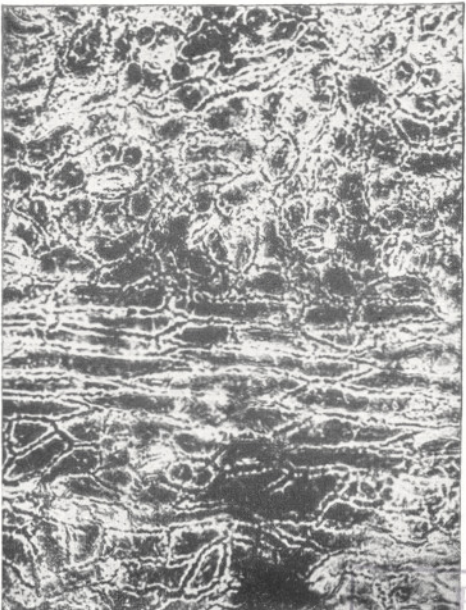
25



27



28



29



30

B. S. S. I.  
LIBRARY  
Acc. No. 41029

## PLATE 3

17-19. *Dicroidium papillosum* sp. nov., Nos. 34010 (Fig. 17), 33934 (Fig. 18) and 33953 (Fig. 19).

20. *D. papillosum* sp. nov., showing distribution of stomata on lower surface; Slide No. 33957-1.  $\times 40$ .

21. *D. papillosum* sp. nov., showing papillate epidermal cells and a few stomata; Slide No. 33952-1.  $\times 250$ .

22. *D. papillosum* sp. nov., a single stoma with papillate subsidiary cells; 33957-1.  $\times 500$ .

23. *Dicroidium gopadensis* sp. nov., rachis cuticle, showing epidermal cells and a few stomata; Slide No. 33962-3.  $\times 150$ .

## PLATE 4

*Dicroidium gopadensis* sp. nov.

24-25. Holotype No. 33962 (Fig. 24) and 33960 (Fig. 25).  $\times 1$ .

26-27. Specimens magnified to show venation; No. 33958 (Fig. 26).  $\times 2$  and No. 33961 (Fig. 27).  $\times 3$ .

28. Lower cuticle, showing distribution of stomata; Slide No. 33962-1.  $\times 40$ .

29. Stomatiferous and non-stomatiferous regions on lower side; Slide No. 33962-1.  $\times 150$ .

30. A single stoma showing striations on guard cells; Slide No. 33962-1.  $\times 500$ .